Integrated E-Learning Web Services

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Abstract— **The present paper focuses on means of creating integrated web e-learning services by providing learning and dedicated information systems facilities within a web portal. The information system facilities are obtained by integrating into a global web portal the dedicated services and synchronizing databases based on various technologies (php / postgresql, asp / MS sql). The portal is based on MS technology and provides, as learning services, management content and e-learning facilities for various user categories, together with dedicated information system facilities.**

Keywords: web services; system integration; database synchronization; e-learning services.

I. INTRODUCTION AND WORKING FRAMEWORK

In the framework of the knowledge based society, information technologies strongly impact on the learning processes [16] and organizational management by means of dedicated information systems. Information system integration has been tackled in the literature especially for business and organizational processes [11]. System interoperability has also been dealt from a semantic point of view [12] .

This paper presents a framework for integrating an e-learning system with dedicated information systems for managing organizational processes for a higher education institution. The proposed framework enables data and service integration that may be further exchanged within federated web services [10], [19].

The paper aims at describing a system integration framework for providing web services into a global portal, including web-based facilities offered by dedicated information systems. The portal we describe has mainly learning purposes (but they may be adapted to various information sharing & communication needs), is based on Microsoft - MS technology and provides means of integrating various information systems, using different technologies (php / postgresql, asp / MS sql). In this respect, we describe an integrated architecture using a ILM - Identity Lifecycle Management [25] server, and additional interface modules, used in order to integrate the dedicated information systems into a web portal that also provides e-learning

facilities, based on SharePoint Portal functionalities*. Based on the principles regarding the way in which data types are structured in organizations' databases and used by different components of integrated software systems, ILM can synchronize and optimize data access and delegate processing means to the appropriate dedicated software components.

Section 2 describes integration principles that we have designed and are in train of being implemented. In Section 3, we present the web services that are provided within the portal: learning facilities, virtual labs and dedicated information facilities, while Section 4 focuses on the web portal and its assessment from the administrating and maintenance points of view, in order to prove its flexibility and adaptability advantages.

II. SYSTEM INTEGRATION ARCHITECTURE

The web-services that we deal with have mainly educational purposes and are made available within the integrated e-learning portal that we are in train of implementing. In order to ensure the integration of our e-learning portal with the dedicated information systems (AcademicInfo, ManageAsist, Research Management System – see 3), we have designed an advanced system integration framework that we further describe.

Integration principles are based on an integrated authentication solution, which maps facilities from the dedicated information systems into the portal, for each user category [6]. The authentication server associates, to each user group, the facilities that correspond to their permissions in each of the dedicated information systems AcademicInfo, ManageAsist, Research Management System, in order to make them available within the portal – see figure 1.

The MS architecture managed by an ILM type server is used in order to ensure single sign-on capabilities and uniform interface to the dedicated information systems. In this respect, we are in train of designing interface modules in order to map the portal authentication into each dedicated system.

A global synchronized database is in train of being created, the most important common information being the human resource & organization chart ones, retained in the dedicated tables [6]:

User[userid, account, password, unitid]

Unit[unitid, unitname, …]

Organization_chart[unitid, superior_id, horiz_id]

This common database, used by the ILM server, will also contain user and group authentication information, together with dedicated permissions in each of the information systems, in order to ensure access to corresponding permissions in AcademicInfo, ManageAsist, Research Management Systems.
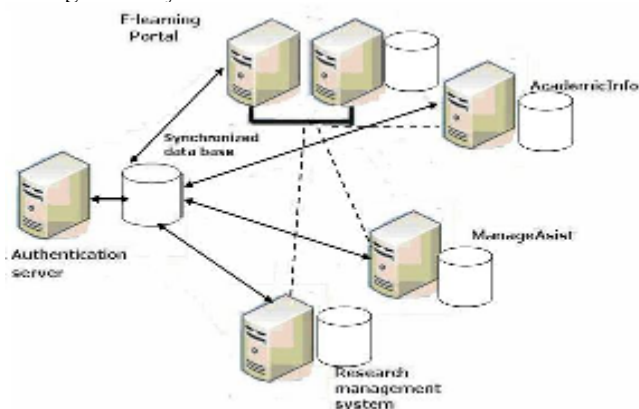

Figure 1: Framework for advanced system integration

The integration solution is also designed to ensure database synchronization among AcademicInfo, ManageAsist, Research Management System and Portal databases based on matching the following data [6]:

◊ portal – AcademicInfo: users (all categories), curricula, study contracts, grades, fees
◊ portal – AcademicInfo – ManageAsist: organization chart, human resources, managers, financial information
◊ portal – AcademicInfo – Research Management System: research activities, PhD Students
◊ portal – ManageAsist – Research Management System: organization chart, units, human resources, grants & corresponding financial information

A major issue in the implementation of the global database synchronization is that the applications use 2 database management systems (PostgreSQL for ManageAsist and Research Management System and MS SQL Server for AcademicInfo), while the synchronization scheme is a multi-master one, each of the databases requiring bi-directional synchronization with the master database – see figure 2.

On the other hand, this solution ensures significant autonomy functional advantages for information systems,

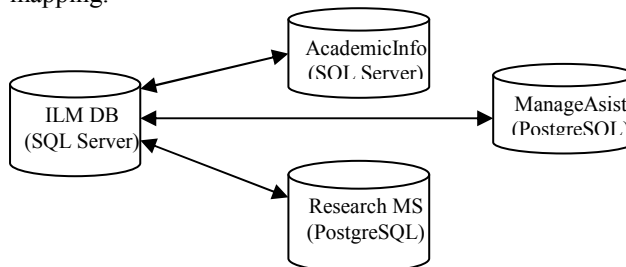compared to a direct Active Directory integration & mapping.

Figure 2: Synchronization scheme

The MS SQL - PostgreSQL synchronization has been tackled in literature [18]. Although a certified multi-master synchronization is fairly complex, in our case, the information that has to be synchronized / replicated between all databases is reduced to a few tables (see the description above for details): users, organization chart, units, people, with a fairly low modification rate, and therefore inducing a moderate network load.

We are currently implementing a synchronous database replication, in order to obtain real time synchronization. Since such a process is quite resource demanding, we also intend to explore some asynchronous mixed solutions if the run time of the global synchronizing & monitoring system tends to increase over a reasonable limit. The asynchronous solution transfers the whole database, having a larger data load, but the moment in time will be chosen in respect with the applications' low workload or even stand-by state.

In order to implement the authentication server we use MS Identity Lifecycle Management server, which has advanced integration facilities with our e-learning portal, and we are in train of configuring the necessary permission mappings from the dedicated information systems into the authentication server in order to complete the integration facilities.

III. THE WEB SERVICES

We further describe the web services provided by the e-learning portal. A prior portal version is already available at [23]

A. E-learning functionalities

E-learning systems [14] may be viewed as advanced tools which assist teachers in creating a cooperative, multidisciplinary and explorative learning environment and students in accessing these learning facilities and developing learning interactions within this environment. The implementation of e-learning facilities strongly contributed to the development of the student and goal centered learning model [1]. E-learning facilities are usually provided by means of web services.

The web-based e-learning facilities provided by the described portal are the SharePoint (see [17]) built in ones, adapted to our specific needs, and include:

◊ content management (see Figure 3) and sharing,
◊ schedule management and sharing,

◊   communication facilities (e-mail – OWA type, discussion lists, etc.) ,
◊   evaluation tools and feed-back facilities;
◊   task management, blog and RSS tools,

◊   survey tools, as well as other functionalities.
The system is also open to adding new web-parts, services or components (for example, the evaluation ones are in train of being developed).
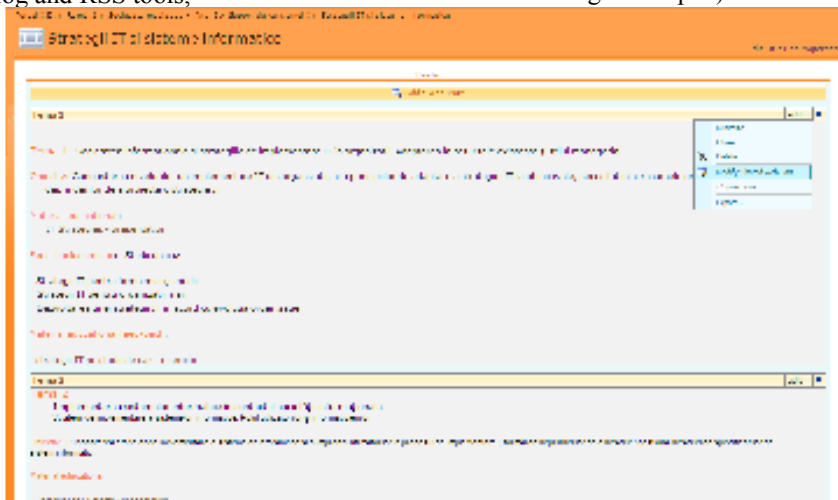

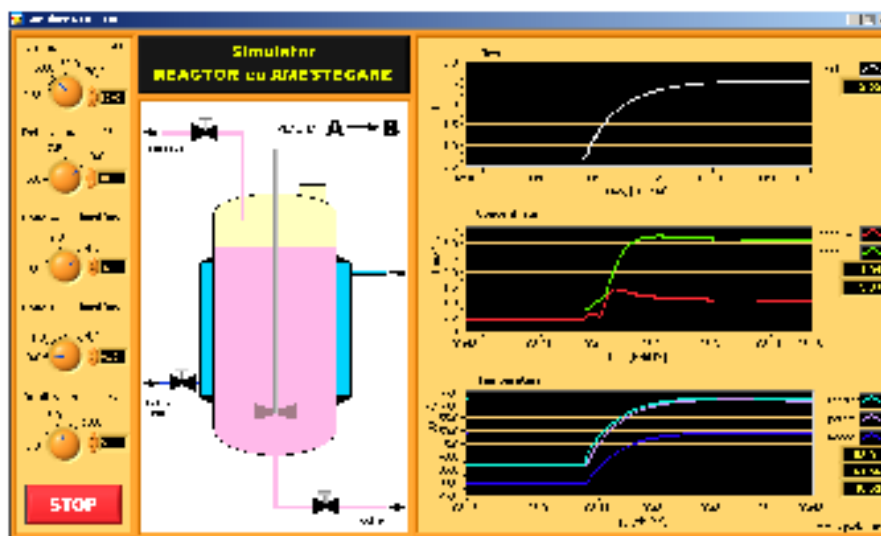**Figure 3: Managing an educational resource (in design permissions)**

Figure 4 Example of simulation process

B.   Virtual lab facilities

Virtual lab services enable modelling of processes that may be tedious to be accessed in real conditions, or are required to be accessed remotely. We decided to include such facilities in our e-learning portal in order to support learning in experimental sciences and sharing of such (typical) experimental knowledge by electronic means. Application fields are related to: process engineering, environmental engineering, physics, chemistry, biology, etc.

The virtual labs facilities are in train of being implemented on the portal and include:
◊   On-line virtual experiments and on-line labs;
◊   Case studies based on mathematical modelling and simulation;

◊   Recorded video sequences and on-line video streaming;
◊   Material posting, to be further processed with dedicated clients

An example of simulation process is presented in figure 5

C.   Dedicated services provided by the information systems

AcademicInfo [20] is an integrated information system dedicated to managing educational information, with dedicated processing facilities for secretariats, specific access facilities for students and teachers and relevant synthesis regarding the educational process. The system models educational processes at BBU level, ensuring course selection from all faculties' curricula in study agreements, models in a flexible manner various types of educational activities at all study levels (BA, MA, PhD, continuous

education, specific curricula), ensures multilingual support in processing and reporting.

The dedicated web services that are provided include:

◊ *For students*: student curricula and grade access, fee management, student documents and requests, on-line course evaluation;
◊ *For teachers*: curricula and grade management (for the activities that are conducted), access to results of student evaluations;
◊ *For academic management*: specific syntheses, access to results of student evaluations at faculty or university levels

ManageAsist system is the integrated software system for administrative management that has been developed for our university. The system can be viewed as an ERP system; within its design and implementation, we integrated systematic efficiency principles in software design – see [6].

ManageAsist's principles and facilities are adapted for high education institutions; the system contains the following modules: Document management, Assets, Warehouse, Cashier, Finance, Accountancy, Grants, Human Resources and Acquisitions, and decision assistance facilities. Their implementation has pursued systematic and efficient principles [2]. Each module contains management reports for the corresponding compartment. Relevant synthesis from each compartment will be integrated, together with global management tools into a decision support module.

In [4] we address the advantages of pursuing advanced design principles in the implementation stages of the system, and in designing a flexible framework for efficiently integrating the system's modules. We also deal with means of managing hierarchical data structures, together with efficiency issues in respect with processing them. Each module includes levels [6] for specific document processing, operational facilities and reporting, level that provides management assistance information for the corresponding compartment.

The web services [21] include access to grant financial information and management of acquisition request, including specific reporting facilities for management levels.

Our **Research Management System** [22] is a web based system that we have developed and implemented within Babes-Bolyai University's (BBU) in order to manage research activities. The system offers – via web interfaces – accessible and user-friendly means of collecting specific information, and automatically performing quantitative analyses, syntheses and evaluations based on the collected information. The system may be viewed as a tool for quantitative research evaluation, its more general aim being to ensure proficient management of the research activity within BBU and supporting the design of competitive strategies in the field by means of this dedicated software system.

The system provides specific web-based facilities for:

◊ *Academic and research staff:* activity collection and reporting;
◊ *Unit / department management*: specific syntheses
◊ *Faculty / university management*: specific syntheses

The design and implementation principles of the Research Management software system, its architecture features and its impact in research activity management for the members of the academic & research staff, but especially for research management levels: chairs, institutes, departments, faculties, university are described in [3].

IV. WEB PORTAL EVALUATION

The web portal that we have implemented in order to provide e-learning and web integration facilities is based on a SharePoint solution, which has proven to be very convenient in flexible administration and integration purposes.

A. Evaluating E-learning Portal Functionalities

Regarding the system feed-back, we developed dedicated questionnaires for administrators, students and teachers [6], in order to obtain a general evaluation regarding existing facilities, platform functionalities and to ensure future developments.

The questionnaire has been created and interpreted using the survey functionality built-un in the platform (Share Point Portal); we underline in this respect the flexibility of the platform's tools.

We further discuss the results obtained consequent to monitoring the administrators' survey [8], since administration facilities are relevant for the portal capabilities.

Administrators were requested to evaluate, on a 1 – 5 scale (1=very weak, 2=weak, 3=moderate, 4=good, 5=very good), the following platform characteristics [6]:

◊ *administration functionalities* - the average weighted grade was 4.14;
◊ *communication functionalities* - the average weighted grade was 3.86;
◊ *functionalities for administering educational content* - the average weighted grade was 4;
◊ *functionalities for developing educational content* - the average weighted grade was 3.43;
◊ *functionalities for platform development* - the average weighted grade was 4.43;
◊ *platform adaptability / flexibility characteristics* - the average weighted grade was 3.57;
◊ *reporting facilities* - the average weighted grade was 4.

We can notice that all characteristics are positively rated, most of them being qualified above 'good' (weighted grades >=4).

We further discuss some of the most relevant responses in respect with the platform characteristics: *administration functionalities and functionalities for developing educational content* are well rated: 29% very good, 57% good, 14% moderate – see figure 5, 6; *functionalities for platform development* are very well rated: 43% very good, 57% good – see figure 7.
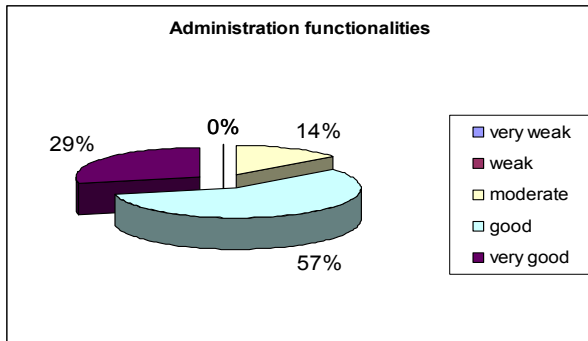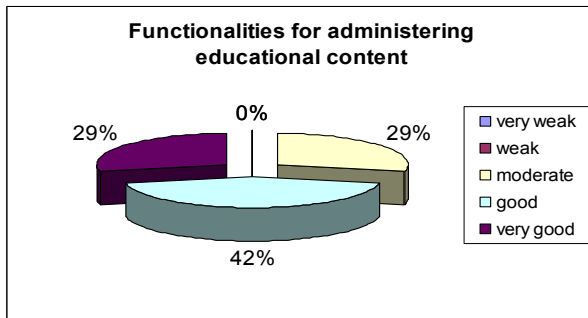
Administration functionalities

Figure 5: Administration functionalities

Functionalities for administering educational content

Figure 6: Administering the educational content

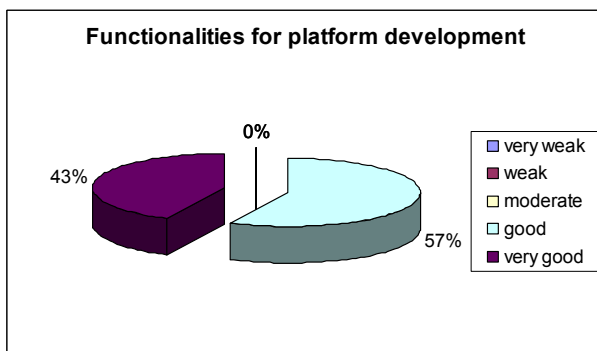**Functionalities for platform development**

Figure 7: Functionalities for platform development

We may conclude that the adaptability and flexibility characteristics of the platform that were mainly aimed are actually implemented and we have a very good feed-back in this respect.

We shall continue monitoring the system in order to ensure its most appropriate use and development; in this respect, we are confident that our prerequisites regarding adaptability specifications in system upgrades will also prove to be very useful in the future.

B. Authentication Characteristics

Our system provides single sign-on [28] facilities using a MS ILM - Identity Lifecycle Management Server [25] and ISA Server; the authentication is based on Active Directory facilities.

While OpenAuth protocol [26] grants access whithout sharing passwords, the architecture we describe uses the ILM facilities for synchronizing authentication information (User,

password), according to [25]. This credential exchange is similar to the one used by OpenID protocol [27], but is performed by means of the ILM built in facilities [25]. The authentication mechanism also implements the MS Domain Trust policy [24].

We consider that the architecture based on ILM server [25] has good implementation advantages, since it already provides built-in web authentication facilities.

C. System Overview and Perspectives

E-learning implementations should pursue the same principles and stages as for other dedicated software systems [2] - the user involvement within the stages of system requirements, verification and implementation are of outmost importance for a successful implementation. Though e-learning facilities are fairly standardized, it is important to take into account future upgrades of the implemented system.

The implementation of the present e-learning system and the undergoing integrated portal within "Babes-Bolyai" University of Cluj-Napoca [5], [6], Romania systematically applied the above described principles. The flexibility system requirements and de-centralized system administration that were pursued are expected to prove their efficiency in the future developments.

V. CONCLUSIONS AND FUTURE WORK

The paper focuses on web service integration and tools for system integration as advanced tools for providing such integrated services. Our case study is performed on an academic institution, the universities' case being quite complex, since their activity covers a wide range of areas: education and learning, research, administration.

We describe an efficient integration solution for providing web services into a global portal, including web-based facilities offered by dedicated information systems. The solution is based on MS technology and provides means of integrating various information systems by implementing a single authentication server and mapping specific facilities from the dedicated information systems, using different database management systems, into the portal, for each user category. This architecture is based on a global integrated database and a permission mapping scheme for ensuring appropriate access into the dedicated information systems. We are in train of defining the necessary permission mappings in order to fulfill the implementation.

The system framework integrates various web services that are provided within the portal: learning facilities, virtual labs and dedicated information facilities.

The advantages of the proposed solution rely in providing a uniform web framework for: database synchronization of various information systems databases and web access to e-learning and information collaboration & sharing tools and dedicated system facilities. The proposed framework enables data and service integration that may be further exchanged within federated web services.

This web service integration solution has a good extensibility degree and may be applied in various cases.

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