Integrating Learning Management System and Faculty Information System – Service Oriented Approach

Petar Bjeljac *, Igor Zečević * and Branko Perišić *
* Faculty of Technical Sciences, Novi Sad, Serbia
pbjeljac@uns.ac.rs, igor.zecevic@uns.ac.rs, perisic@uns.ac.rs

Abstract - The current era of information technologies opens new challenges brings new approaches concerning the use of computer supported Learning Management Systems (LMS). Nowadays, the majority of higher education institutions utilize information systems for handling administrative data, while some of them have successfully introduced one or more LMSes. On the other hand, the majority of LMSes rely on an encapsulated subset of administrative data, causing data redundancy with the administrative database. If the LMS supports learning activities which need to be scored, there is a strong need for reverse flow of relevant data from LMSes back to the administrative system. The need for the development of a moderation layer becomes a must. In this paper a brief analysis of the developed architecture of a moderation layer, the state of the art and the further development direction concerning the Faculty of Technical Sciences in Novi Sad information system architecture extending to the LMS integration are presented. A service oriented approach for two-way data exchange between these systems is proposed as a flexible solution.

I. INTRODUCTION

The proliferation of IT use is causing changes in all aspects of life. Among these changes, a change to the learning process has been made by the expanding use of Learning management systems (LMS) on higher education institutions.

An LMS [1] is “a software application that automates the administration, tracking, and reporting of training events”. These systems ease student-teacher communication, as well as the distribution of teaching materials. However, several problems rise due to the amount of administrative tasks teaching staff needs to execute in order to prepare this system to adequately support the teaching process.

Learning management systems contain different types of data:
- Course structure data;
- Teacher and student data;
- Group and enrollment data; and
- Grading data.

On the other hand, in most cases the faculties already have an existing system (or several systems) for handling this type of data. These systems are called Faculty Information Systems (FIS). A Faculty Information System is a single system, or a set of systems, used for executing administrative tasks at higher education institutions (student, staff, course administration etc.).

In this paper, a solution for integrating LMSes with an existing FIS, using a service oriented approach, is presented. The paper focuses on a prototype implementation, providing data exchange from the FIS to LMSes. This is initial work in the process of integrating these separate systems into one complete solution for handling administrative, as well as teaching tasks at faculty level.

The rest of the article is organized as follows. The second chapter describes the current Information System (IS) state at the Faculty of Technical Sciences (FTS) in Novi Sad, which is used as proof of concept in this research. Furthermore, the custom requirements for the integration process are analyzed. The third chapter presents existing solutions and compares them to these requirements. It also gives a description of an existing standard for integrating LMSes. In the fourth chapter, a solution, based on RESTful web services is described. Finally, in chapter five, conclusions are made and the directions for future work are outlined.

II. CURRENT STATE AT THE FTS

The Faculty of Technical Sciences in Novi Sad is the largest faculty at the University of Novi Sad, with approximately 13000 active students and 1000 members of teaching staff. It consists of 13 departments, with 87 study programs. The teaching process administration for such large institutions presents a complex task, which has been supported for years using several information systems, building a custom FIS for the FTS (Fig. 1). This IS consists of the following elements:
- The Accreditation IS – used for structuring courses and preparing study programmes for the accreditation process;
- The Human resources IS (HRIS) – used for the administration of teaching and non-teaching staff; and
The Student IS (SIS) – used for the administration of students and their grades, as well as real-time course administration and distribution of teachers and students to courses.

In the last couple of years, several departments have made effort in adopting the use of contemporary LMSes in their teaching process. Currently, three departments use an LMS to support their teaching process: The Department of computer sciences uses Canvas LMS [2], whereas the Department of industrial engineering and management, as well as the Department of electronics use implementations of Moodle LMS [3], adapted to their specific needs. As opposed to other FIS subsystems, the LMSes have not been centrally implemented by the FTS IT service, primarily due to the fact that a compromise on using one exclusive LMS system at faculty level has not been made. These systems represent separate systems, with no level of integration with the FIS.

The following requirements for the integration process emerge:

1. A flexible solution, easily extendable to new LMSes, as only 3 out of 13 departments have an LMS, whereas other departments may decide to implement and use a different one.
2. Secure data transfer, as student and staff data is, and should remain, confidential to third parties.
3. An easily usable and understandable integration interface, in order to ease the integration process for the developers implementing the LMSes.
4. A quickly and easily implementable prototype, in order to test the level of usability of such solution for our IS.

III. EXISTING SOLUTIONS

The problem of integrating an LMS with other systems is not new. How the author states in [1] LMSes need an integration with an existing HR system in order to track employees on courses. In higher education institutions, this extends to integration with a Student administration system, in order to execute the same task with students in focus.

Most LMSes, like [2] [3] [4] [5], offer a simple way for data exchange (primarily import) using Comma Separated Value (CSV) or some other format of files. However, using this approach, files containing potentially confidential data, need to be manually imported by the administrator, exposing them to potential data theft. An even larger setback for this integration approach is the fact that different LMSes often use different file and data formats, so a separate data export script would need to be implemented for each system.

Most modern LMSes also have an Application Programing Interface (API), solving the problem of data file exposure. However, the different format (API) problem still remains.

In [6], the authors suggest an approach based on direct data integration. The LMS communicates directly with a copy of the SIS database to access data about users. This approach, although more generic, is not applicable in our case, due to the fact that the LMSes are not centrally implemented and controlled by the FTS IT service.

The same author in [7] states the disadvantage of direct data integration in the process of updating SIS data, for example importing grades back to SIS, due to the lack of authentication, as well as data validation. Here, a business logic level integration is proposed, in order to include the business-level validation of data.
The authors in [8] propose two levels of integration – data and functional integration. An interface is created for data to be exchanged between SIS and LMS. Furthermore, the functional integration of these systems, enabling the user to log in to each of these systems and directly use the functions from the other, is presented. However, no further details about the integration process are available.

A. Learning Information Services specification

Learning Information Services (LIS) Specification [9] is a standard created by the IMS Global Learning Consortium. LIS defines the process for exchanging information which describes people, groups, memberships, courses and outcomes within the context of learning. The specification defines six different types of exchange services:

- Person Management Services – data about students and teaching staff;
- Group Management Services – data about study groups on courses;
- Membership Management Services – data about membership for students and teaching staff – connecting them to courses and groups;
- Course Management Services – courses and course structure;
- Outcomes Management Services – gradebook data; and
- Bulk Data Exchange Management Services – bulk exchange of all data.

These services enable the integration of all LMSes supporting the LIS standard with any IS able to provide interfaces based on the specification. An integration process in full compliance with the Learning information services (LIS) specification is presented in [10].

Although this is a complete solution, based on an industry standard, the standard has not yet been supported by all LMS vendors, and is currently not considered as a solution in the case of FTS. However, this standard represents a base for our proposed solution.

IV. PROPOSED SOLUTION

Analyzing the requirements, as well as existing work in this area, we propose a prototype implementation for a data integration system for exchanging data from our FIS to the LMS. This approach is based on the LIS specification data model and service interfaces, and the implementation of these interfaces using service oriented approach.

A. SOA, REST, JSON

Service oriented architecture (SOA) is [11] an architectural style that supports service orientation. Services are defined [12] as course grained, discoverable software entities that exist as a single instance and interact with applications and other services through a loosely coupled (often asynchronous), message based communication mode.

Representational State Transfer (REST) is an architectural model for building distributed applications based on three distinct concepts: representation, state, and transfer [13]:

- Representation: Data or resources are encoded as representations of the data or the resource. These representations are transferred between clients and servers.
- State: All of the necessary state, needed to complete a request, must be provided with the request. The clients and servers are inherently stateless. A client cannot rely on any state stored in the server, while the server cannot rely on any state stored in the client. This does not, however, pertain to the data stored by servers or clients; only to the connection state that is needed to complete transactions.
- Transfer: The representations and the state can be transferred between client and servers.

REST is most often implemented as a combination of the Hypertext Transfer Protocol (HTTP) and TCP/IP. With this instantiation of REST, HTTP requests are used to transfer representations of resources between clients and servers.

JSON (JavaScript Object Notation) [14] is a lightweight data-interchange format, easy for humans to read and write. Compared to XML, JSON is [15] faster and uses fewer resources, and is on the other hand as widely supported in programming languages as XML.

B. The implementation

Based on the nature of our system, required to support several different types of LMSes, a solution based on a web service implementation on the FIS side is proposed. This approach to the integration process requires a plug-in (extension) to be implemented on the LMS side in order to access the functions. The proposed architecture for our solution is presented in Fig. 2. The system covers the complete integration process, with a Single Sign On (SSO) Service providing access to all LMS systems directly from the student/staff application, and a Data Exchange Service, responsible for handling data import/export tasks. The scope of this paper covers the implementation of Data Exchange Services allowing data export from the FIS.

The web services implemented are based on the LIS specification and consist of the following functions:

- Course export
- Groups export
- Student export
- Teacher export
- Course membership export
Group membership export

The data model for all these web services contains two segments – input and out parameters. Here we present a more detailed description of these services and the data exchanged.

1) Course export

The course export service provides an interface for exporting data about courses and course structure to the LMS.

Input parameters:
- School year
- Semester
- Study program

Output parameters:
- Unique id – containing data about the school year, semester, study program and course
- Name – full course name
- Short name – an abbreviation for the course name

2) Group export

The group export service provides an interface for exporting data about student groups on a specific course.

Input parameters:
- Course id – the id received from the Course export service

Output parameters:
- Unique id – containing data about the course and group
- Group name - a descriptive name for the group

3) Student export

The student export service provides an interface for exporting data about students enrolled in a specific course.

Input parameters:
- Course id – the id received from the Course export service; if empty, all active students are returned

Output parameters:
- Unique id – the id received from the Course export service; student id from the SIS
- First name
- Last name
- E-mail address

4) Teacher export

The teacher export service provides an interface for exporting data about teaching staff responsible for teaching activities on a specific course.

Input parameters:
- Course id – if empty all active teaching staff are returned

Output parameters:
- Unique id – id from the HRIS
- First name
- Last name
- E-mail address
- Office
- Phone number

5) Course membership export

The membership export service provides an interface for exporting data about student and teacher distribution enrolled on a specific course.

Input parameters:
- Course id

Output parameters:
- Student id/Teacher id

6) Group membership export

The membership export service provides an interface for exporting data about student and teacher distribution in groups on a specific course.

Input parameters:
- Course id
Output parameters:

- Student id/Teacher id
- Group id

Apart from these functions, an interface for importing grades from the LMS back to the SIS is planned to be implemented in the Data Service component of our system. However, this interface is out of the scope of this paper.

Fig. 3 presents the class model which supports these interfaces, without attribute details.

Due to REST and JSON simplicity of use and low resource requirements, a decision has been made to implement web services based on these specifications. An example of use is the call to the Teacher export service, which is made as a simple HTTP GET call to an address in the following format:

```
[serveraddress]/teachers/2014.1.L.1.1.SRP.SE1.13.SE0011
```

where 2014.1.L.1.1.SRP.SE1.13.SE0011 is the course id received from the Course export service.

The response received is in JSON format:

```
{"teachers":[{"teacherId":"N361","firstName":"Branko","lastName":"Perišić","email":"perisic@uns.ac.rs","office":null,"phoneNum":"0214852244"},{"teacherId":"N1649","firstName":"Petar","lastName":"Bjeljac","email":"pbjeljac@uns.ac.rs","office":null,"phoneNum":"0214852246"}]
```

and can be imported into the LMS.

V. CONCLUSION

The proliferation of learning management systems use in contemporary educational process opens several challenges to the institutional integrated information system development. However, a large drawback in the adoption of LMSes by institutions and teachers is the amount of redundant administrative work needed for their utilization. This is due to the unavoidable heterogeneity and the lack of integration support mechanisms being the common situations that have to be addressed.

The solution based on RESTful web services, with JSON as the data exchange format, presented in this paper, is easy to implement and use, and represents an open solution that may be extended and improved in a simple manner. Furthermore, the fact that we use a data model similar to the one in LIS specification enables simpler implementation of plug-ins needed for the exchange of data and an easy understanding of all the concepts used. The initial tests were subjected on four courses, on a subset of approx. 300 students and five members of teaching staff. The approach has proved to satisfy all specific requirements at the Faculty of Technical Sciences.

Future work directions are: the implementation of services needed for the import of grade-books back to the SIS; the implementation of an authorization mechanism for these services; the implementation of a Single Sign On (SSO) solution, enabling users to login to one system (SIS), and use functions from other systems (LMS).

REFERENCES