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OKI: The Integration of Technology Enhanced Learning Services

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Abstract: There is now a whole series of technology enhanced learning platforms available in both the field of free software and in that of proprietary software. Choosing one or another in each circumstance raises many doubts. As a solution, the article shows the use of standards to facilitate the integration of tools and functions with existing platforms.

Keywords: Virtual campus, e-learning, Moodle, Sakai, OKI, OSID, LMS, interoperability, integration.

1. Introduction

The choice of platform has taken up significant efforts in technology enhanced learning projects. Typically, choosing a platform represents a future commitment, as its high installation, configuration and learning costs need to be offset. The type of doubts raised by the choice of platform has evolved as the technology enhanced learning sector has evolved. During the period 1995-2000, the first institutions to work in technology enhanced learning were unsure whether to develop a bespoke platform or buy the licence for a market platform and so when this period came to an end, we found that we had a great number of institutions with platform licences such as Blackboard or WebCT.

Between 2000 and 2005, the question changes, few people envisage bespoke development and the question on everyone's lips is: A market platform or a free software platform? By the end of this period, we see many institutions and companies using platforms such as Moodle or Sakai and developing a large volume of code integrated into these platforms. Given that these are free software platforms, the code is available for modification and with not too much effort high levels of personalisation are achieved. And this is the key to the present question: Should we modify the free software platform or program the personalisation of the platform in a standard layer?

Consequently, many are modifying Moodle[i] or Sakai[ii] and if their new code is not included in the new versions, a significant effort has to be made regarding development in each new version. OKI[iii] is a commitment to providing Moodle and Sakai with a standard layer, a layer that allows connections to academic management, a library and human resources management, without modifying the code of the platforms. In both the university environment[iv] and in the business environment[v], projects concerning the integration of technology enhanced learning services based on OKI have been started.

1.1 Architecture and interoperability based on OKI

An evolution in technology enhanced learning products has been taking place in recent years towards technology enhanced learning frameworks. The majority of products not only offer a certain functionality but allow this to be expanded by the addition of new modules, reprogramming or adapting parts, or accessing a programming API. For example, Moodle

offers an entire API for programming new activities or changing certain behaviours. In such a changing and diverse environment as that of technology enhanced learning, the advantages of a framework with regard to a product are evident. So why a specific framework? Why not an abstract and generic e-learning framework? OKI [1][2] is a commitment to providing e-learning services with a standard interoperability layer, a layer that allows connections to many tools and systems like academic management, repositories and others (Fig. 1).

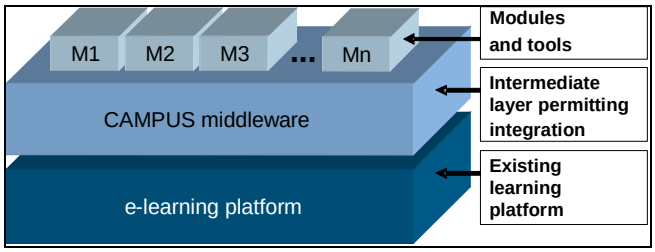

Fig. 1. Architecture by layers.OKI

The Open Knowledge Initiative [1][2], proposes a series of specifications with the aim of fostering the interoperability and adaptability of systems.

1.2 Basic services

Specifications such as OKI OSIDs and IMS Abstract framework [3] define in detail the services that a technology enhanced learning platform should offer. In spite of this, it has been decided to use quite a reduced set of these services. This is because the project focuses on:

- Simplicity.
- Developing in distributed teams.
- Reducing lines of code.
- Keeping the timeline and the investment.

Furthermore, a limited number of services facilitate the integration of external tools. It has been estimated that the average development time needed for tool integration programming through such a set of services is roughly a month.

The criteria to decide the basic services are as follows:

- The minimum set of services
- All of them must be OKI OSIDs.
- Those mandatory for the system to work (authentication and authorization).
- Those enabling the system to be administered and managed as though it were a single product (logging, locale and configuration).

Therefore, the tools developed can communicate with the base platform using a maximum of five services: authentication, authorization, logging, locale (internationalisation) and configuration.

- The authentication service not only allows the user to log into the system but also finds out if the user is logged in. This is a mandatory service in any computer program with user registration.
- The authorization service determines if the user is authorised to act on certain resources and contexts. This is mandatory in any system in which the users play different roles.
- The monitoring service allows program activity data to be stored. It is very useful for finding out what is happening in a system and how it is working.
- The internationalisation service permits the language of a program to be changed and new languages to be added.

- The configuration service allows us to create and change the configuration parameters of a computer application.

These services implement the following OKI OSIDs: all Authentication OSIDs, all Authorization OSIDs, all logging OSIDs, all dictionary OSIDs (used to implement the locale and configuration services), Agent, Id and Group.

1.3 Architecture

The Campus Project started under the assumption that the next step to achieve a real interoperability would rely on adopting a service-oriented model. OASIS [4] defines Service Oriented Architecture (SOA) as a "paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations" [5]. In SOA, the system is modelled around a set of modules with a public functionality and responsibility and a set of mechanisms that allow interaction between the services. When these services implement a very clear-cut interface, then it is possible to isolate the interaction mechanisms in a unique layer (see OKI Bus layer further on), facilitating the control of the loose coupling across the systems. If a loose coupling is pursued, the layer can be implemented using web services. This is the case with the Campus Project, in which heterogeneous tools (Java and PHP) interact with some services of an also heterogeneous platform: Moodle (PHP) or Sakai (Java).

The best way to see it is to think of a system of blocks or pieces that fit together (Fig. 2). Each piece is a black box that performs an activity within its limits and invisible to the others [6]. Consequently, each module has its own internal architecture and most appropriate technology to resolve its business logic.

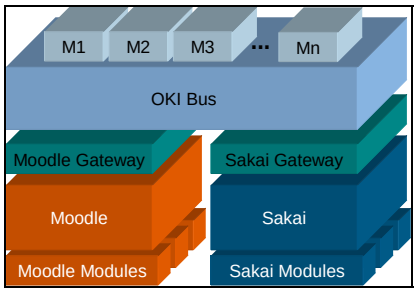

Fig. 2. Architecture by layers.

The modules connect to the system using the base services, which act as a bridge and a link. In turn, the learning platform that wants to use the modules must have an OKI Gateway. An OKI gateway is a piece of software that translates the requests of the base services that use the modules into calls to the platform's API. Each platform has its own. Fig. 2 shows the OKI Moodle gateway (for the Moodle platform) and the OKI Sakai gateway (for the Sakai platform). To integrate a new platform, the corresponding OKI gateway must be used.

One final piece to take into account is the so-called OKIBus. This component is a middle layer that resolves all of the problems relating to the communication between applications. In other words, until now we have described how to make so many base modules speak the same language and be able to understand each other, but what happens if the speakers are far apart and cannot hear each other? And what if there is a lot of noise in the room? The OKIBus layer resolves the equivalent of this type of problem: communication protocols, remote communication, performance optimisation measures, increase in communication quality, etc.

2. The CAMPUS Project

The CAMPUS project [7], promoted by the Secretariat for Telecommunications and the Information Society (STSI) of the Regional Government of Catalonia, grew out of the agreement signed by the majority of Catalan universities to have a virtual campus based on open code and which enables them to offer higher education both online and in a semi face-to-face environment. This initiative came out of the university system open to the world, which aims to become an international benchmark for technology enhanced learning.

This project comes under the Digital University programme fostered by the STSI, the aim of which is to facilitate the transfer and sharing of knowledge using information and communication technologies.

The Universitat Oberta de Catalunya (UOC) is in charge of coordinating and leading the project, which is carried out using the knowledge and experience of each associated university. Each member, therefore, contributes tools and resources to the project, which is organised according to a development community in open code.

Today, the project has over 15 partners who share the development functions of the CAMPUS and the observation and monitoring tasks. The project officially began on 1 April 2006 and delivers its results to the community in 2008.

The aim is to develop a technological infrastructure with free distribution tools to provide online training. The project requirements are: open code and open standards, user-centred design, interoperability between tools and with other systems, scalability of the solution, high concurrence of users and processes, OKI OSIDs [8] specifications as a mechanism of interoperability, which can be executed and integrated into Moodle and Sakai open code e-learning platforms and with a service-based architecture of the solution.

On a functional level, CAMPUS is a solution designed for virtual learning that contemplates the usual functions of an LMS (Learning Management System), but which also offers modules that can be executed and integrated into the model and Sakai platforms (through OKI) and which bring added value to the functionality offered by these platforms. In particular, functionalities are added which are not present in Moodle and Sakai or which are similar tools but with different pedagogical orientations, or which contribute another type of differential value.

2.1 Organisation of the project

Often the organisation and type of relationship established between the constituent agents of a project mark out and determine many of its decisions, risks and results. Therefore, it is important to provide certain data regarding the structure and organisation of the project.

The project members are basically universities and public bodies that play the roles of developer, observer and financer. The project has a budget of around three million euros, financed largely by the Regional Government of Catalonia.

No legal body has been established to represent the project, so each university is legally responsible for maintaining and overseeing the evolution of its tools.

The project management is conducted through a Gforge [9] project development environment; specifically, the La Farga [10] open-code project development and promotion. An environment of this type offers a set of tools that can be used to manage projects. For example, distribution lists, debate forums, wiki, files area and a version control tool, among others.

The project is divided into eleven work packages, each with a set of universities involved. The packages are:

1. User analysis and profile structuring.
2. Model development and interface testing following usability and user-centred design criteria.
3. Central system and security design.

4. Description of subsystems.
5. Central system and security development.
6. Development of subsystems.
7. Usage pilot.
8. Opening up free software to the community.
9. Legal framework and community.
10. Dissemination and opening up of the project.
11. Methodology, quality control and risk management.

2.2 Applications portfolio

CAMPUS offers a portfolio of applications that give added value to the project and which are contributions by the various universities. Some of these tools have already been working successfully in each university and have been brought to the project because of their success and solidity, others offer an added value as they are innovative, others offer specific functions or cover specific pedagogical methodologies; in short, the CAMPUS Project should be seen as a set of applications that fulfil a specific need in the field of technology enhanced learning and which can be integrated on the most common learning platforms.

The following outlines some of the most interesting applications in the portfolio:

- Live e-learning: This is a technology enhanced learning support system based on multicast technology through real-time audio and video broadcast. It permits the broadcasting and recording of multicast sessions of master classes by the lecturers. The lecturer's voice and video and the PC's desktop are broadcast with the application that is currently active.
- Internal messaging: Internal messaging module for the users of a campus.
- External e-mail – Webmail**:** Webmail manager. It permits the exchange and management of both internal and external mails. It is an integration project of the well-known Zimbra [11] mail management tool. It is not intended that the Internal messaging and External e-mail tools should coexist in the same CAMPUS implementation, rather what is expected is that according to needs, one or the other is used. If external mail is required web mail will be chosen, otherwise internal messaging will be sufficient.
- Results assessment and reporting tool (QTI): System based on the IMS QTI standard to describe the data structure of questions and test results. It allows the creation of questions and exams online, for them to be shared through the QTI specification and for their appearance to be personalised. It is an integration project of the 'Quaderns Virtuals' [12] tool and an extension of the calculation engine to incorporate statistics and advanced graphics on the basis of the QTI Results Reporting data.
- Automatic problem correction: Automatic problem correction is a teaching support virtual environment, which consists of the personalised allocation, correction and assessment of problems for each student. Unlike the QTI application, this tool is designed for problems of complex resolution, such as mathematical problems, programming algorithms or diagramming. It is an integration project of the ACME tool [13].
- 3D Virtual Environments: The most widely known 3D virtual space is Second Life [14] but there are other tools that allow creation and interaction with 3D worlds and which are completely free. The tool developed is integrated in a classroom of a virtual campus and allows users to access a virtual space, using a personalised avatar, where they can view and manipulate 3D objects created by the lecturer. It is an integration project of the OpenSimulator project [15].
- Teaching content monitoring (SCORM): The teaching content management and distribution system in SCORM allows the platform to import, export and display

learning materials that meet the SCORM 2004 specifications. The system enables monitoring data to be stored using an AJAX API and accepts content sequencing strategies.

- Student portfolio: The electronic portfolio is a system that enables the students to submit work to the lecturers to show their progress in the attainment of skills. It is an iterative process where the lecturer comments on the students' work so that the students can improve on it.
- Bookmarks: The aim of these is to provide users with access to key pages on or off the platform on the Internet. As new feature, it offers the capacity of sharing, participating and labelling, which makes it a tool of personalisation and collaboration.
- Wikis, blogs and podcasts: Despite the fact that these tools are now very widespread, that every platform has their own and that their election very often depends on personal preferences, it has been decided to include them as an example of the ease of integration that the CAMPUS offers.
- RSS Mobile/TV: The RSS Mobile/TV is a system that allows information from the campus environment to be received or consulted on various devices, such as hand-held devices (PDA, telephones, etc.) or living-room devices (TV). The system is based on RSS syndication technologies.

3. SUMA Project

The Suma project was created within the eLearning working group [16] of the INES [17] technological platform.

As a result of the experience of the project partners that were part of the INES technological platform e-learning group was the detection of a lack of standardisation in the technology enhanced learning solutions available on the market and which are now being implemented. There are now a great number of both Open Source and proprietary and bespoke platforms.

This situation involves a great deal of individual effort by the companies that implement technology enhanced learning environments to develop the solutions that customers expect in each case. Each project involves significant development technological effort to adapt to the customer's needs and integrate as easily as possible into a business environment.

Consequently, in most cases, the effective incorporation of technology enhanced learning into a company involves a great deal of effort and high costs, which mean that it is not within everyone's reach. Due to this, the major e-learning experiences are found mainly in large companies and in many cases are outside the reach of medium and small companies.

In addition, a significant distance has also been detected between research being carried out in the university environment in both the field of standards and processes and education methodologies in technology enhanced learning. There have been many developments in the theoretical sphere (definitions, models, etc.), but little has been put into practice effectively (beyond reduced pilot trials).

The consortium of companies, technology centres and universities (which participate as subcontracted parties) brings together companies' knowledge on the needs of the technology enhanced learning market with the innovative standards and solutions being developed in the academic field. This situation has enabled an integrating approach to be taken for the construction of a service-oriented platform that unifies new applications and standards currently available in the technology enhanced learning field.

Due to all of this, the Suma Project is also based on the solution proposed by OKI as architecture based on integration standards for e-learning tools, adapting it to the specific

needs of the business environment and promoting the transfer of technology between university and business.

There are plans to construct a series of e-learning functions on the services integration layer, which will allow the basic tools of the underlying platform beneath the integration layer to be completed.

These applications will be basically of three types:

- Integration modules with business systems: the aim is to meet the needs in this field based on the experience of implementing technology enhanced learning environments (in both the business and academic sphere) of the companies involved in the project.
- Multimodal access modules: aimed basically at providing access to the platform through Interactive Digital Television (IDTV) and mobile devices as an innovative solution to an access channel to an e-learning platform.
- Intelligent/adaptive learning creation and management environments: to transfer the mature research lines in this field to industry.

This way, the end result will be a complete platform with innovative e-learning functions that facilitate connectivity to pre-existing platforms in both the business and academic field.

The project is presented as a three-year plan (2007-2009) and has secured a subsidy for 2007 from the Ministry of Industry, Tourism and Trade of the PROFIT- ICT Industrial Policy of the 'Avanza Plan'.

4. Conclusions and future work

The CAMPUS project completion date is also a beginning. The commitment is to open all the developments to the community in the form of an open-code project. Therefore, the success of the project will be measured by the use that the community makes of these products and components. A great deal of effort has been invested in ensuring that the developments will be of interest to the educational community and also in providing a sufficiently modular structure that enables everyone to use what strictly interests them.

The structure of the project, with many actors involved, has greatly helped achieve this aim. Each university involved already had experience in virtual teaching and its own learning platform with truly interesting tools. Some universities have a very clear orientation towards free-distribution products, such as Moodle or Sakai, others have their own learning platforms. Achieving a solution design that is compatible with the interests of everyone and which, in addition, is of interest to the educational community in general, has not been easy.

The results of the projects includes the OKIBus and the gateways with a set of technology enhanced learning applications that interoperates with the platform using the OSID standard as one of the first implementation of the OKI OSIDs to build a complete technology enhanced learning solution and that allows the easy integration of new technology enhanced learning platforms (building a new gateway) and any new application that uses OSID.

The innovation of these projects rely on that can guarantee the interoperability of technology enhanced learning platforms and applications using an open standard. To integrate any application to one of the existing technology enhanced learning platforms involves specific development for the platform.

Another important factor is the desire for international projection. To achieve this, from the start we have been committed to open standards and to integrating everything possible and respecting the work lines and objectives of everyone. In this sense, the mechanisms for integration with Moodle and Sakai have been planned and discussed with the managers of these projects. We have worked closely with the MIT OKI working group to transform the

project into a benchmark implementation of its specifications and have encouraged the incorporation of education standards in the tools and modules of the project.

The future plans are to develop the use of the project components, to initiate a set of pilot trials to validate developments and to secure more financing to continue working together.

The UOC is committed to basing its Virtual Campus on these components and to follow the architecture and principles set out by the project. The adaptation carried out during 2008 so that UOC's LMS may have OKI OSIDs defined services, is another sample of this concept. The UOC's LMS is a self-made product and has been used as e-learning platform at UOC for more than 10 years. At present, the UOC has over 45000 students, an average level of concurrence over 2500 users connected simultaneously and 6000 maximum users connected simultaneously at peak times like delivery of activities and the beginning of semester. In addition, many of the universities involved are interested in working on evolving tools and integrating them into their organisations.

For its part, the Suma project, which at the time of writing this paper (June 2008) has completed its first year of operation, still has two years to run which will focus on the development of the tools, some necessary and others innovative, to construct a useful platform for the business environment that facilitates the incorporation of technology enhanced learning, with a clear commitment to integration through standards of the multiple applications that currently exist in companies.

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