

# Joint Degrees in E-Learning Systems: A Web Services Approach

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**Abstract**—In order to allow the development of joint degrees through heterogeneous E-Learning Systems, we propose a federation services architecture whose implementation will be based on Web Services. Our main objective is to allow E-Learning Systems to be able to work in a collaborative way; combining their data and functionality through the integration of their services. These services will be combined and federated, according to collaboration agreements between Universities. Joint degrees through E-Learning systems will allow the development of new joint curricula and the participation in the convergence of Higher Education.

*Joint Degrees, SOA, Web Services, Federation, E-Learning Systems, Collaboration.*

## I. INTRODUCTION

In the unstoppable process of globalization and educational convergence, technological, pedagogical and political initiatives are boosting the development of E-Learning.

At the technological level, E-Learning Systems (E-LS) offer electronic support to the educational and administrative processes of academic programs.

Pedagogical models are being studied and proposed for self-direct learning [1].

At the political level, the development of a European Space for Higher Education is being promoted and is widely known as the Bologna Process [2]. The main objectives of the process are the convergence of European higher education, the recognition and quality of degrees and the improvement of international competitiveness in the European educational system.

According to a report by the European Association of Universities [3], joint degrees have an intrinsic link with all of the goals of the Bologna Process because it encourages a close collaboration among different countries. Furthermore, E-Learning has a great potential to meet the objectives established in the Bologna Process.

Considering that E-Learning and joint degrees are rapidly growing trends, it is necessary to take into account the role of E-LS in the development of joint degrees. The most important problem is the heterogeneity of educational and administrative

processes. For this reason, it is necessary to find a suitable solution to enable universities to design joint degrees through their own E-LS.

A wide range of research proposals concentrate on the interoperability of learning resources, the federation of identities and E-Learning Frameworks. However, the joint degree scenario requires the creation of new services, as well as the interoperability of additional E-LS functionalities.

In this paper, we propose the design of a federated service-oriented architecture which, through collaboration agreements (federation), will permit the interoperability of functionalities. The proposal for its implementation is based on Web Services.

The remainder of this paper is organized as follows. Section 2 gives a definition of joint degrees. Section 3 introduces the main challenges of joint degrees and E-LS. Section 4 shows a functional model that allows the main components of our approach to be identified. In section 5, we introduce our proposed architecture and its main components. Section 6 proposes some of the aspects for its implementation. Conclusions and future work are set out in section 7. Acknowledgments and References are presented in sections 8 and 9.

## II. JOINT DEGREES

According to a study on Master and Joint Degrees in Europe [4], “Joint degrees are normally awarded after study programmes that correspond to all or at least some of the following characteristics:

- the programmes are developed and/or approved jointly by several institutions;
- students from each participating institution study parts of the programme at other institutions;
- the students' stays at the participating institutions are of comparable length;
- periods of study and exams passed at the partner institution(s) are fully and automatically recognized;
- professors from each participating institution also teach at the other institutions, work out the curriculum jointly

and form joint commissions for admission and examinations;

- after completion of the full programme, the student either obtains the national degrees from each participating institution or a degree (in fact usually an unofficial “certificate” or “diploma”) awarded jointly by them.

### III. JOINT DEGREES IN E-LEARNING

In this context, we may define joint degrees as a type of academic degree offered by two universities by means of E-LS. Unfortunately, the heterogeneity of E-LS limits the interoperability of contents and services, impeding the collaboration functioning between systems. Most E-LS use owner formats to describe the information they manage.

A great effort is currently being made by the research community to develop initiatives that will allow the interoperability of a learning repository. Among these initiatives we may find: standards and specifications for the content repository such as the IEEE Learning Object Metadata (LOM) Standard, Sharable Content Object Reference Model (SCORM) and IMS Learning Resource Metadata; search interfaces such as Simple Query Interface (SQI) [5]; semantic network of interoperable educational systems [6] and educational federated repository systems such as CORDRA [7].

However, in the context of joint degrees, these solutions are insufficient bearing in mind the necessity for the intervention of additional functionalities such as the design of joint curricula, the establishment of federation agreements and the management of joint degrees. Therefore, the implementation of joint degrees by means of E-LS requires the solution of several

technical difficulties generated by the heterogeneity of systems. Analyzing existing E-LS, the following challenges would be taken into account:

- Allowing the joint creation of curricula based on collaboration agreements between universities which would define access policies and use of services that will form part of the degree.
- Allowing the interoperability of E-Learning, in other words, that information by both systems can be understood and interpreted correctly. shared
- Allowing the autonomy of E-LS in the development of the learning content, in other words, allowing each system to use its own data models.
- Allowing the shared management of users in heterogeneous systems.
- Allowing the single registering of students. Their identities must be shared with the other systems.
- Providing access control and security.
- Managing educational credits.

The expedition and acknowledgement of joint degrees require the adaptation of a legal framework in most European countries.

### IV. THE FUNCTIONAL MODEL

In order to identify the main components of our architecture and understand the functionality of E-LS as a support for joint degrees, we have designed a functional model as illustrated in Fig. 1.

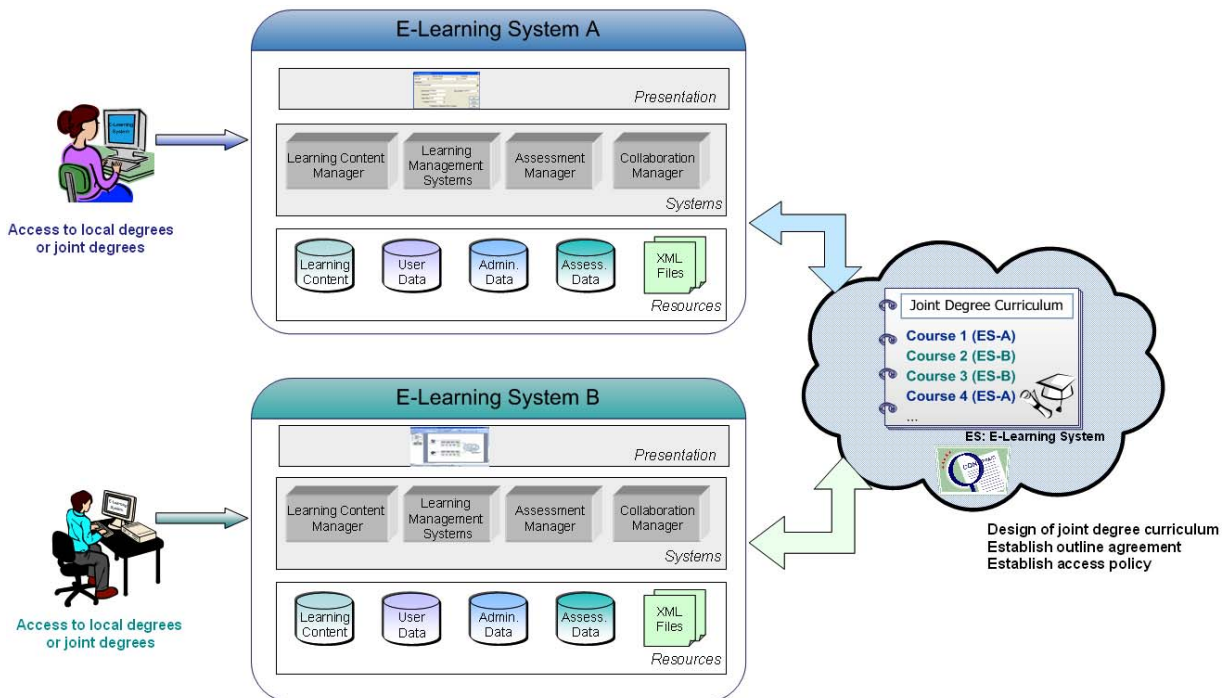


Figure 1. The functional model

Two or more E-LS may participate in the development of joint degrees. To make it possible, universities should establish collaboration agreements. The curriculum must then be designed by the administrators of each E-Learning system, who will select and publish the courses that will be part of the curriculum. Each institution can offer subjects or courses for the curriculum. Although, these subjects or courses will be located and given in different E-LS, they will constitute the same study plan.

Students interested in joint degrees can use any of the participating learning systems when registering and choosing their course. It will not be necessary to register users in each system. The identity and preferences of users will be controlled and administrated by a central entity who will share the user's information in a secure environment.

## V. PROPOSED ARCHITECTURE

In the area of distributed services, the services are a cluster of functions that allow functionality of an application to be shown through interfaces that can be reached through the network. The services can be combined, with the objective of constructing and offering new possibilities. Therefore, the use of services in the E-LS will allow the creation of a series of new helpful functionalities between them.

Taking these premises in account and considering the requirements listed in the section on joint degrees in E-Learning, we suggest the design of an architecture based on the service federation between E-LS

Our main objective is to allow the E-LS to be able to work in a cooperative way; combining their data and functionality through the integration of their services. Therefore, we can define a joint degree as an academic program, made up of a cluster of services that is offered by the universities through their E-LS. These services will offer support to the academic and administrative processes, all of which are included in an academic program. The services will be combined and federated, according to an agreement established by the universities involved. In other words, those universities which form part of the joint degrees will establish a collaboration policy.

The development of the architecture will allow the universities the following functionalities:

- Facility in the integration and reuse of learning systems.
- Possibility to set up new services, without the imperative need to implement them.
- Best exchange of the learning content.
- Establishment of access policies for the services.
- Participation in the development of new academic programs that will enlarge the academic portfolio.
- A higher demand for the offered academic programs offered through the E-LS.

Interesting initiatives have proposed frameworks based on a service-oriented approach for E-LS, such as: an E-Learning

Framework (ELF) [8] that provides a collection of services clustered into logical groups to aid readability; Sun Microsystems [9], their suggestion is made up of 4 layers: presentation, common services, e-learning services and resources; Open Knowledge Initiative (OKI) [10] developed a series of interfaces for service definitions, called Open Service Interface Definition (OSIDs). They give a reference implementation for each of them. In each of the suggested frameworks, the services are grouped into logical clusters according to their functionality. For example, learning services (e.g. Assessment) and common services (e.g. Authentication) are two common categories of services.

The services defined in the existing E-Learning Frameworks are very useful to support typical E-Learning applications. However, the development of a joint degree through these frameworks is not possible because of the lack of services oriented toward the management of the joint curriculum. Taking these aforementioned frameworks and models as a reference, we propose the design of architecture, based on service federation for the design and implementation of joint degrees between E-LS. The overall architecture is illustrated in the Fig. 2.

### A. Service provider

In our architecture, the service providers are the E-LS. They are responsible for publishing and offering the services that allow access to the other E-LS services. The services defined have been grouped into logical cluster just like the other frameworks. At the service level, the main difference between the existing E-Learning Frameworks and our approach is the creation of a new service category called "Joint Degrees Services". The objective of this category is to define the missing services in other frameworks to allow the development of joint degrees in E-LS. From our point of view, the following services should be implemented into each E-Learning platform:

- Design of joint curricula.
- Establishment of collaboration agreements and access policies.
- Managing the degrees: Coordination and control in carrying out the service.
- Notifications Service, reporting any events in the services.

An E-LS plays the role of a service provider (by offering access to its local services) and the role of a service requester (by accessing other federated services). Each service provider should allow access to the administrative and academic content of the programs. To be able to achieve this goal, the administrators of E-LS, will have to publish the information on the federated services they offer in a service Broker.

### B. Service broker

The participant E-LS, are interconnected through a service Broker. This Broker is responsible for managing the federation of the services. With the objective of guaranteeing the service federation, a security token will be required by each service in

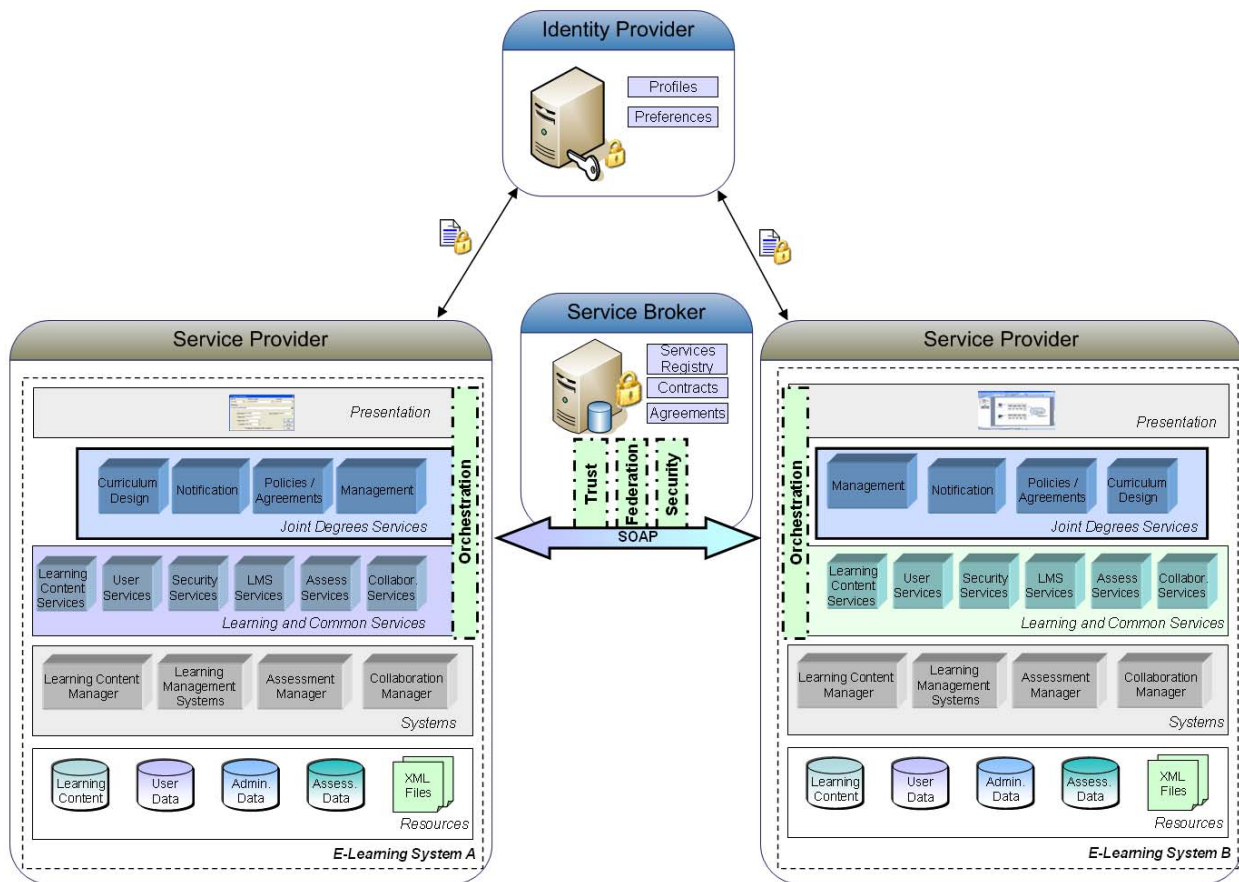


Figure 2. Proposed Architecture

order to execute it. This security token will be managed and provided by the service Broker.

The curriculum of a joint degree, designed by the universities involved, will include the courses in the academic program as well as the assessment and practice processes. Each element of a joint degree is identified as a service. Therefore, the curriculum will be made up of a service brochure located in different systems.

Once the curriculum is established, the academic program requirements should be fixed. The Service Broker will manage the design and requirement definition process. In order to control the behavior of E-LS in the context of joint degrees, collaborative contracts must be defined between E-LS. A contract or agreement should specify the services that E-LS can access from the federation as well as those it offers to the federation. Additionally, a contract should specify the following aspects:

- Security access policies for the services: type of encryption, method of authentication, rules of business and privacy.
- The admission requirements that students must fulfill to get into the academic program. For example, the required education level, languages etc.
- The joint curriculum

- Credit format and assessment systems.
- The lasting and conditions of the federation.

The contract management will be managed by the Service Broker.

### C. Identity Provider

The Identity Provider (IP) is responsible for the control of identity and the validity of users. In other words, responsibility for identity federation. The IP will permit the registration process of the joint degrees to be carried out just once and through any of the participating systems.

## VI. IMPLEMENTATION ASPECTS – WEB SERVICES

The implementation of joint degrees in E-LS requires the overcoming of difficulties which, in turn, implies the heterogeneity of E-LS and diverse educational structures. In the following section, we will present some of the implementation aspects based on Web Services that are relevant to our proposed architecture.

At the level of Service Provider, the services grouped into category: “Joint Degrees Services” must be implemented as Web Service within each E-Learning platform. The services grouped into this category require the specification of their interfaces. We are currently working on it. The methods

specified to the Joint Curricula Service are set out in the table 1.

TABLE I. JOINT CURRICULA SERVICE

Method	Joint Curricula Service		
	Description	Returns	Parameters
ListCourse	This method compiles the list of courses available to design a Joint Curricula.	resultList Element	NameE-LS String[]
Assignment	This method updates the joint curricula according to List received.	resultInfo Element	List Element

At the level of identity federation, significant initiatives are under way, some significant examples are: Liberty ID-WSF [11] and Shibboleth [12]. Each of them supports the “Single Sign On mechanism”, that allows the users to access the resources that are part of a federated environment; using only one authentication validity. For the information exchange of the user, we propose the use of the specification IMS Learner Information Packaging (LIP) [13] that defines the information interchange of students between the E-LS.

To define collaboration agreements, managed by the Service Brokers, we propose the use of WS-Federation [14], WS-Security [15] and WS-Trust [16]. These specifications allow the construction of trust-federated sceneries and provide support for multiple security tokens, signature formats and encryption technologies. The security token should be sent to the service providers by the service Broker, in order to authorize the carrying out of the service.

BPEL4WS [17] is a specification that describe how the operation of the services can be sequenced. BPEL4WS is essentially a layer on top of WSDL.

To specify the requirements of an academic program, specification IMS Content [18] could be used. To make the search and access processes with educational content easier, we propose the use of LOM to describe educational resources.

Finally, at the level of assessing specifications, we propose the use of IMS Test and Question (QTI) [19].

## VII. CONCLUSIONS AND FUTURE WORK

The key for the interoperability between heterogeneous E-LS is the service federation. We have proposed a federated service-oriented architecture for E-Learning Systems in order to allow the development of new collaborative functionalities such as joint degrees.

Service Oriented Architecture provides a correct framework to control and develop these kinds of degrees. It is important to encourage service building in the E-LS to make the communication and integration with other systems easier.

Our research continues in the field of architecture implementation. Our purpose is to develop a prototype that allows the implementation of the architecture shown. To achieve this goal, we will use open source E-LS, such as: Claroline (<http://www.claroline.net/>) and Moodle (<http://moodle.org/>). We are currently working on the

development of interfaces that will make the design and managing of joint degrees easier, as well as the agreement specification between E-LS (Contracts).

## ACKNOWLEDGMENT

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