LOP2P: Architecture for Institutional Learning Objects Sharing

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Abstract: This paper presents an interoperability architecture to allow different educational institutions share their learning object repositories for creating courses using Learning Management Systems (LMS). The initiative is in line with a current trend in educational institutions to produce learning objects and make them freely available through web repositories. The proposed mechanism is based on Peer to Peer architecture where each institution is a peer. This paper details the two main components of the architecture, plug-in for LMS like systems and the Mediation Layer. Some implementation issues are also discussed.

Keywords: Learning Objects, Learning Management Systems, Courseware.

1. Introduction

There are many definitions for Learning Objects (LO) (Wiley, 2000), (LTSC IEEE, 2007), (Quinton 2007) e (Taylor, 2007), but there is a common point: the reusability feature. This reusability guarantees that one digital instructional material can be used and applied to various educational purposes, in different places. For this feature to be more effective, the sharing of LO needs of the institutions overcome some existing barriers.

The use of virtual learning environments on learning institutions is quite common. This kind of software manages the learning of students, offering a environment for a specific course where, basically, teachers and students may interact (Irlbeck, 2007). This software is commonly called LMS: Learning Management Systems.

The use of LO standards on LMS (like SCORM (ADL, 2004), IMS Content Packaging and IEEE LOM (IEEE LTSC, 2007)) are facilitating the employment
of Learning Objects on learning institutions. This approach fosters the creation of LO by these institutions.

When institution that does not allow use, or can’t share theirs LO to others learning institutions, it is certainly diminishing the chances of LO to be used more times. So, there are many LO that are used only by the institutions that create it.

Other problem of LO sharing is the isolation of LO repositories. There are many Learning Objects repositories with free content, but they are not effectively used for support creation of courses with LO philosophy: they don’t allow integration with software of learning institutions (LMS).

The isolation is considered a problem because the main philosophy of LO are reusability. If a LO is shared to more than an institution, its reuse may be greater than if used by only one. The main advantages on LO sharing are:

− when a LO is constructed focusing a learning theme, there aren’t necessity of to construct others LO for the same theme, avoiding the creation of others LO for a same purpose;
− an LO with a extended theme can aggregate other LO that are in the network, if the LO license allow that;
− when a LO becomes more used, more people can contribute with evolution of the LO, helping the creators to improve it;
− gives to teachers a larger amount of materials to create courses for his students.

The distribution of Learning Objects, as well as any learning material, should preserve the copyrights of their creators, but that should not disallow the use of them.

This paper presents architecture to establish a network to provide interoperability between institutions that have rights of Learning Objects and desire to share the use of its and institutions. The architecture is designed to connect educational institutions interested in sharing and use of Learning Objects through a single network, named LOP2P (Learning Object Peer to Peer). The main objective is to facilitate the connection of a largest possible number of institutions, making a contribution from a larger number of interested institutions, sharing and using LO from other creators.

The connection among the institutions is offered through two mechanisms: a layer of interoperability called the mediation layer, for connection to the network, and a plug-in that connects the LMS of the institution to mediation layer. The following services are provided by LOP2P:

− Learning Object Publish: publishes the LO in the local network, to display them in searches conducted by other institutions;
− Search for Learning Objects: realizes search for Learning Objects in institutions connected in the network;
− Download of Learning Objects: after a search, LO with free use license can be downloaded;
− Visualization of Learning Objects: for LO that are configured to not be downloaded, there is the possibility to visit him, to use it online.
The architecture has a philosophy of sharing of Learning Objects, very similar to systems of file-sharing Peer to Peer. The main difference is that the purposed architecture share LO between institutions rather than personal computers. An important observation is that in this architecture each institution connected are considered a Peer.

This philosophy inherits the Peer to Peer model, which adds the following advantages cited by (Maibaum, 2002):
- not maintain a central structure, which demand higher cost of maintenance;
- make initiatives independent of a centralization posture in which any change in behavior of the central initiative affect the entire network;
- network continues work if you disconnect any peer;
- more uniform sharing of resources with a greater number of peers;
- have better performance and require less bandwidth;
- shared resources can be used more efficiently: increase the sharing of LO.

Another feature of this network is the possibility the entrance of repositories of Learning Objects, which should be made as easy as institution integration in the network. With this connection, a LO repository can offer their LO for all institutions connected in the network.

The paper is organized as follows: section 2 presents LOP2P architecture; section 3 discusses some implementation issues; section 4 presents a conceptual discussion about LOP2P creation; and section 5 presents final considerations and future works.

2. LOP2P Architecture

This section has the objective to demonstrate the architecture proposed in this paper for creation of interoperable network for sharing LO: called in this article LOP2P.

The learning institutions generally have learning environments (online in Internet), where students can access the instructional material, interact with teachers or others students. The architecture LOP2P connects the institutions with the network-sharing LO through these environments (LMS). Thus, access to objects from other learning institutions is done through the environment itself (LMS) available for teachers, coordinators, supervisors and so on.

This approach facilitates the use of the network of the institution by people who are interested in using or promote sharing within the learning institutions, because there isn’t a new environment to be used, but the connection to the environment of the institution with a network LOP2P.

Another characteristic of a LOP2P architecture is that although the institution is connected with several others, the complexity is abstracted because all operations
occur in the network as if they were only one institution, facilitating the use of the network.

For the features mentioned above to be possible computationally, it has been established the LOP2P architecture. The architecture specifies two types of software to ensure interoperability: the plug-in and Mediation Layer.

### 2.1 LOP2P Plug-in

LOP2P architecture has been developed taking into account the structure of LMS, this software is called plug-in, because they are installed as part of LMS.

The LOP2P plug-in must have some features for integration with the mechanism of communication with the network. As requirements of plug-ins software should consider the following scenario:

- the plug-in should be developed using the same programming language in which the LMS was created, because must be integrated in the LMS;
- communication with the mechanism of connection to the network (mediation layer) should be done through an API that allows sockets over TCP/IP. A great number of languages have this API natively, such as C++, C#, Java and PHP.

Figure 1 shows the architecture of the plug-in installed on the institution's LMS. The plug-in is connected to the Mediation Layer through sockets. Thus, the plug-in can do requests or send requests to the Mediation Layer, which is connected to network LOP2P. As the plug-in is inserted into the server application of the LMS, the institution is connected to network LOP2P. It is important to note that the applications runs on the LMS server.

![Figure 1. Plug-in architecture for LOP2P.](image-url)
2.2 Mediation Layer

The communication with a network of LMS LOP2P could not be achieved by the plug-in, because the complexity of communication with the network to be abstracted by other mechanism, called the Mediation Layer. This approach is used to facilitate the development of plug-ins for different LMS.

The Mediation Layer promotes the communication with the LOP2P network and offers the services of the network to the plug-in, thus allowing the LMS to share and use Learning Objects.

Another important feature of the Mediation Layer is the specification of services that should be available for sharing of Learning Objects. The four network services supplied by LOP2P architecture are based on IMS Digital Repositories Interoperability (IMS, 2003) and are:

- Search / Expose: service responsible for searching for Learning Objects;
- Gather: should be based on the standard OAI Protocol for Metadata Harvesting (OAI, 2004): establish service functions to create and maintain intermediary repositories. These repositories do not store Learning Objects, but the object metadata. In LOP2P, intermediary repositories are created in all institutions of the network, maintaining a list of metadata from other Learning Objects of others LMS. Thus, the LMS to collect metadata from other repositories routinely in order to maintain updated information and to avoid many faults in the search for Learning Objects.
- Request / Deliver: this service has the function of providing a means for the display of Learning Objects. An institution makes the request on the Mediation Layer view of an object previously searched. The Mediation Layer calls viewing the institution in which the object is and forward the requester;
- Submit / Store: service responsible for receiving request to download a Learning Object from a learning institution connected to the network and trigger. It also makes the transmission of Learning Object of one learning institution to another.

The Figure 2 shows the architecture of the Mediation Layer. It receives requests and sends responses to the plug-in that is in the LMS.
It is known that the Learning Objects are described by metadata that are shaping the information on the subject of how to understand the use of it, without the need to run it. There are several standards of metadata to describe Learning Objects. The most commonly used for this purpose are DublinCore and Learning Object Metadata (LOM). Given this diversity, and as one of the main goals of the architecture LOP2P is to provide interoperability, the Mediation Layer must be addressed with a software for the translation of metadata. The translation of ontologies must occur through the mapping of ontologies (Gašević, 2006): technique in which two metadata can be translated from one to another, through a mapping identifying the similarities between the metadata.

3. Implementation Issues

In order to promote a more mature discussion of the architecture LOP2P, this section shows an experiment in the development of a prototype that consists of two software: a plug-in for MOODLE LMS (developed in PHP programming language) and a Mediation Layer (developed in Java programming language).

3.1 Implementation of Plug-in

The purpose of the plug-in is to connect the LMS of the learning institution to the Mediation Layer LOP2P for sharing of Learning Objects. To mature the specification of architecture of plug-in for LOP2P, one software for this purpose was developed and attached to an installation of MOODLE.
The plug-in for MOODLE has produced the format of "Box". The Figure 3 shows visually how it presents for teachers, coordinators and supervisors, allowing aggregate of Learning Objects in their courses.

![Figure 3 Plug-in for LMS MOODLE.](image)

The implementation was done using the PHP language. The communication with the Mediation Layer was done through the sockets API of PHP. As MOODLE accepts plug-ins made by other initiatives, the adequacy of the Plug-in LMS was performed without complications, since the MOODLE's framework was used.

The implementation lasts about fifteen hours of a only programmer with experience of one year with the LMS, and 4 years with PHP language.

### 3.2 Implementation of Mediation Layer

Mediation Layer's goal is to ensure communication with the network of LMS LOP2P. For the Mediation Layer that communicates with the plug-in installed on the LMS, offering the services of the network LOP2P.

The main functions of the Mediation Layer are: ensuring the four services of the network LOP2P, communication with the network Peer to Peer is that LOP2P and communication with the plug-in of LMS.

A well conducted implementation of Mediation Layer can serve to all institutions that can connect the network. To ensure this characteristic, the Mediation Layer should be implemented in portable language, or languages that can be run on several different computers with different operating systems (Windows, Linux, Solaris, ...). Because of this, the implementation was held using Java language using JXTA framework. JXTA was chosen for having an active community and being used by other researchers in the field (Mailbaum, 2002), (Bisignano, 2003) and (Signeur, 2003). With this framework the implementation
of the mechanism of communication with the Peer to Peer network was held abstracting the difficulties of implementing Peer to Peer software.

Communication with the LMS was implemented using the sockets API of Java, which has not generated difficulties or incompatibilities in the exchange of information with the plug-in sockets generated by PHP.

The implementation of the Mediation Layer lasts about thirty hours allocating a only programmer with experience of 5 years of development in Java.

4. LOP2P Network

The architecture of LOP2P allows to implement network interoperability between learning institutions that seek to use or publish Learning Objects.

It is known that there are several repositories of Learning Objects. These repositories are large databases that store the objects and allow the retrieve of them through an interface for people and/or computer software. Some of these initiatives are ARIADNE KPS (Ternier, 2002), Edusource (Hatala, 2004) and RIVED (Nascimento, 2008).

An institution wishing to connect with various repository of Learning Objects must establish individual connection to each of the initiatives that provides the repositories.

The architecture LOP2P can be used to add these repositories to LOP2P network. What should be done is to create a plug-in LOP2P to the mechanism for recovery Learning Objects and connect it to a Mediation Layer. Note that not only LMS can be part of the network, Learning Object Repositories (LOR), Learning Content Management Systems (LCMS) and other LOWare\(^1\) systems can also be used since they have an developed plug-in.

The LOP2P network follows a Peer to Peer philosophy where each learning institutions is connected with the network as a peer, thus forming a network between institutions devoted to the sharing of Learning Objects. A philosophy in the most widespread network LOP2P is sharing of Learning Objects with free licenses for use, because the share of the architecture favors this approach.

The architecture has the purpose of attending learning institutions, then there will not be problems related to the misuse of the Peer to Peer network, called as free-riders problem, who are users who use the facilities of decentralized networks to publish material in an unlawful manner.

\(^1\) LOWare systems: Any kind of system that deals mainly with learning objects creation and/or visualization.
5. Final Considerations

This paper has the object to presents the LOP2P architecture: full technical details about the architecture would be impossible to cover in a single article. Because this, that paper presents the main features and guidelines of the architecture, with the intention to demonstrate the purposes and viability of the LOP2P.

There are others initiatives for sharing Learning Objects: ARIADNE (ARIADNE, 2008), Edusource (Hatala, 2004), Edutella (Nejdl, 2002), LOMster (Ternier, 2002) e ROSA P2P (Brito, 2005). The originality of LOP2P architecture is in establish features, characteristics and technologies to integrate learning institutions in a single peer-to-peer networking, connecting through the existent LMS, considering the institutions as peers. Other important characteristic of the LOP2P architecture is the possibility to connect LO repositories.

The LOP2P architecture is dedicated to sharing Learning Objects with a free license of use. In this sense, the network can also be a channel to improve the potential of use for good open source Learning Objects.

The main future work is to test the mediation layer with several different institutions. For this the plug-in developed will be delivered to MOODLE community in order to find partners for this experiment.

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