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ECONOMIC APPROACH TO ENSURE INTEROPERABILITY BETWEEN LEARNING MANAGEMENT SYSTEMS

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ABSTRACT

In this paper, we propose an innovative concept of "Application Service Provider LMS (ASP LMS)" which promotes the opening and the interoperability of the learning management systems (LMS) and the sharing of learning services and resources. The goal of this opening is to make the interaction between systems easier, to facilitate the sharing of resources and services between systems. With the introduction of this economic model this system widens the market of the Open and Distance Learning (ODL).

INTRODUCTION

Within the framework of our projects of learning management systems (LMS), aiming at the opening of our platforms, we were and still are facing two main problems for which we propose economic solutions. On the one hand, lack of opening of the LMS, due to their internal and global vision of the services offered by the learning management systems generated by their current operating mode. On the other hand, the lack of consensus at an international level, but also the absence of unique standard. The choice of standard to respect or to adopt is an issue today. Indeed, from one side, except for the promotion and reception services, a learning management system offers a mode of management oriented towards services reserved to internal management and intended for registered users and thus recognized by the system. One of the consequences of this global approach to the services is that the existing offers are global, by purchase or by lease. From the other side, if it is true that the establishment of the standards in the Open and Distance Learning aims at ensuring the interoperability of the resources and the systems; this form of interoperability is not reached yet. The about compatible one is more frequent than the perfectly compatible one. For the moment, one rather notes a diversity of learning management modes [2] [5] [11]. The pedagogical contents are still not easily portable.

However, we note that today many companies have both specific contents and systems owners. Other companies, particularly small busnisses, have contents, but, for several reasons (lack of means to invest in the purchase or the leasing of a complete system, problems of compatibility with the existing systems, etc.), are not ready to acquire a learning management system. Certain companies would like to be able to use these pedagogical contents online without having to acquire a complete learning management system for the reasons mentioned above or simply because they already have it and that they do not wish to change. The needs for institutions to share pedagogical resources are acute today. From the user's point of view, ideally, any learning management system should function with any pedagogical content, in a transparent way, while preserving an optimal performance, whatever the authoring system of these pedagogical contents.

Then, one remembers the context in which the ASP (Application Provider Service) [27] [28] [29] was born. This is a contractual service of deployment, hosting, management and hiring of data-processing applications hosted in an externalized central point. We include in this paper this vision of the services and we adapt it to the context of the ODL by proposing services to be developed surrounding the learning management systems and where the ASP becomes a system says "provider" which provides the application services to other systems known as "customers", in the form of Web services.

The objective is to propose a complementary solution to the problem of interoperability, to promote the opening of the learning management systems and consequently to facilitate the opening of the market which these tools constitute. This step is based on the concept of the Application Service Provider System which we will define further down. The first services which we will deal with in this paper are about two services: contents services management and follow-up learning activities management services. Companies involved in delivering e-learning products have also to invent new economic model better suited to ever moving users needs.

The following section describes how the general operation is performed and the basic functionalities of a learning management system.

FUNCTIONING OF A LEARNING MANAGEMENT SYSTEM

A learning management system is an information processing system which makes it possible to produce, integrate, present, broadcast a training offer on line, administer resources, animate, and implement the management and the follow-up tools of the training activities. These systems are made of functional bricks which govern the effectiveness of integration of the contents on line. If one wants to ensure a certain level of pedagogical follow-up and to further go than the simple provision of resources, the contents must be identified by the assignment of values on follow-up variables. These variables must have a form that can be identified by the data processing services which surround the contents. Their integration improves the effectiveness of the pedagogical follow-up and makes it possible to identify strategic information. It is more and more current to find multifunctional learning management systems. Their possibilities range from assistance to the learner to the setting online of the contents for blended learning. They also include their own management, individualized teaching courses management, as well as the management of synchronous and asynchronous communication tools, and the administrative follow-up…

The learning management systems can thus cover various aspects of learning ranging from administrative management to the interactive diffusion of pedagogical learning. Among the most widespread functionalities we can quote : the learning management which includes the administrative management, the management and production of the contents, the asynchronous and synchronous accompaniment of learning, and the management of competences.

The type of management here is oriented towards internal services; each user must initially connect to the system to have access to the services available. For each phase of the global learning process [6], the learning management system offers various tools of synchronous and asynchronous communication. It also offers sharing and knowledge production tools.

Concerning the pedagogical follow-up, an extreme sophistication is not needed. However, we observe a diversification of the pedagogical approaches which can use various technological solutions. The solutions ensuring a certain co-education of the approaches are necessary.

Moreover, the concept of learning management system is enriched by new functions. At present, certain products propose functions integrated in their learning management system : electronic trade, management of competences, learning quality management, contents production, etc. Whereas we note an increase in demand in terms of functionalities and interoperability of the resources and systems, the problems of compatibilities remain. As far as formats are concerned, XML tends to be adopted like almost universal support to facilitate the service and data exchanges. From the point of view of the direction to be given to information thus exchanged, much remains to be made. In the following section, we specify how the question of interoperability in the learning management systems arises, in particular according to two points of view: the one based on the standards and the one based on the Web services. In the following section, we specify how the question of interoperability arises in the learning management systems, in particular according to two points of view: that based on the standards and that based on the Web services

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INTEROPERABILITY WITH THE WEB SERVICES

Definitions

The interoperability [3] [4] [23] [24] between systems is assured when several systems, that are identical or radically different, can communicate without difficulty or ambiguity. It is the capacity of the systems to exchange data or to interact, but also the capacity of a software application to function with tools and within diversified frameworks.

In the domain of Open and Distance Learning, this concept relates to the creation of contents in a platform using an author system and their reusability, their diffusion in another platform. It thus concerns the interoperability between contents and learning management systems and the interoperability between systems. An ideal situation, from the user's point of view, would be that any learning management system functions with any content, in a transparent way, whatever the author system of this content. It is not the case today, and several studies highlighted the differences between the learning management systems from the point of view of interoperability, in spite of the answers given by the standards or recommendations such as AICC, LOM or SCORM.

Before introducing the concept of ASP LMS, we initially present the two most widespread forms of interoperability.

The interoperability based on Web services

The A Web service [3] [12] [[13] [22] is a component (application) Web established in any language, deployed on any platform and wrapped in a layer of descriptors in standard formats derived from XML. This type of application can interact dynamically with other programs by using protocols of exchanges based on XML like SOAP. The concept of the Web services is currently articulated around the three following acronyms:

- SOAP (Simple Object Access Protocol) is a protocol of inter-application exchange independent from any platform, based on XML language. A SOAP call of service is an ASCII flow framed in XML beacons and transported in HTTP protocol.
- WSDL (Web Services Language Description) [16] gives the description to the XML format of the Web services by specifying the methods being able to be called upon, their signature and the access point (addresses, port...).
- UDDI (Universal Description, Discovery and Integration) provides an interoperable, foundational infrastructure for a Web services-based software environment for publicly available services and services only exposed internally within an organization.

The Web services thus allow interoperability with a unit of open XML-based standards. They offer an environment of deployment which is essential for the creation of dynamic systems of electronic training and favour the Application to Application Interaction. Even if certain problems of use deserve to be underlined [20], we can note their adoption successfully in software engineering, in particular by ERP [24].

The Web services are an application of the SOA (Service Oriented Architecture) [25] [26], an architecture based on the capacity to locate, publish, and call services. Thus, the use of the Web services by the LMS enables them to integrate a service-oriented architecture and thus of interoperate between them or with other systems. The Web services continue an old dream of the distributed data processing where the applications could interoperate through the network, independently of their platform and their language of implementation.

The interoperability based on standards

Today, the standards of the online learning domain [15] [16] [17] [18] [19] aim to guarantee the interoperability of the systems but also the traceability of the courses and the re-use of the contents. All the OLD actors agree that there is a need to use these standards for the implementation of distance learning devices to ensure the portability, reusability, and interoperability. Most advanced research on standardization relates to the metadata to describe

pedagogical objects. The principal goal of this standardization is to facilitate the reusability of these numerical resources since their production is often difficult and expensive.

The development, by way of consensus, of international specifications covering technologies of the Open and Distance Learning is in the hands of the ISO (ISO group: IEC JTC1/SC36 [16]). But we are still a long way from the word "standard". For lack of consensus, the problem rather arises in terms of choice of standards to respect or adopt. Thus, the respect or the adoption of a standard such as SCORM or AICC, which is a guarantee of opening and duration, is today a significant criterion at the time of the choice of a learning management system. So far, the interoperability based on standards has not been reached yet. The "near compatibility" is more frequent than the “perfect compatibility”. A genuine standard adopted by the set of the learning management systems still remains to be established.

Thus it seems interesting to propose, with the provider systems, a set of solutions less dependent on the standards, which are still under development.

THE APPLICATION SERVICE PROVIDER SYSTEM MODEL

How can we access the resources and the services offered by another learning management system from a customer system without being directly connected to it? This is the object of this section.

We define a "Application Service Provider System (ASP System)" as a system placing at the disposal of other systems known as "customers" of the application services online and lodged rental mode. Each customer system grows rich thus by these new services which come to be added to its internal services.

Within the online learning framework, these services are offered by a learning management system. We will develop in this section the first two examples of the services offered by a provider system, namely the services of the contents management (making the pedagogical contents accessible) and the services of the pedagogical courses management, in particular the pedagogical follow-up management.

From a customer system (Intranet, learning management, etc.) how to reach the resources and the services offered by another learning management system (known as “provider system”) without being directly connected to it? That is the object of this section.

Interaction situations between systems

In the functioning of the provider system model, a system customer is a system which uses the external services suggested by the provider system, in particular the services of access to the contents and management of pedagogical courses.

A system customer of a provider system can be a Web site, an Intranet, a gate of a company or a learning management system. The communication between systems is carried out with the standard protocols and with the Web components calling upon the services provided by a provider system.

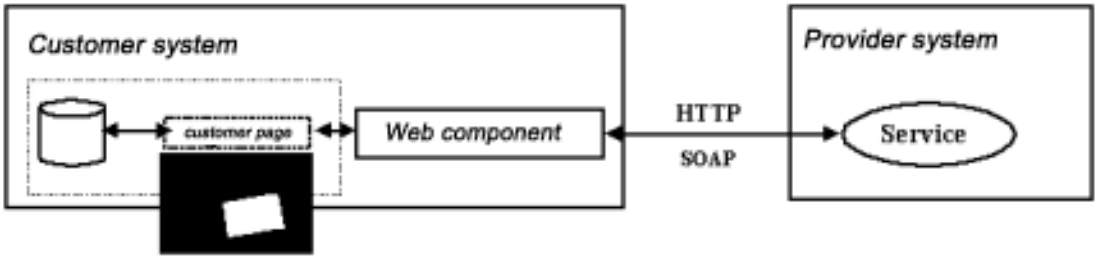

Figure 1 Example of interaction between systems.

Table 1 Interaction situations between systems

	Provider system	Customer
Pedagogical modules	Declaration of the pedagogical contents Access authorization to the pedagogical contents	Ask declaration of the pedagogical contents Access authorization to the pedagogical contents
Follow-up, Pedagogical Courses	Setting with data layout of pedagogical follow-up Setting with treatment services of pedagogical follow-up data	Access to pedagogical follow-up data Access to treatment services of pedagogical follow-up data

The table below presents various situations of interaction between a provider system and a customer system.

In the two following paragraphs we will detail the mechanisms of contents management on the one hand and the pedagogical courses on the other hand.

Mechanisms of content management

The mechanisms of contents management relate to the mechanisms of contents declaration at the level of a provider system and the mechanisms of external access to these contents. To make sure that a customer system benefit from the services of a provider system, it must declare its resources at the level of this provider system. These resources can be hosted on any system and thus not necessarily at the level of the provider system. For each declared resource, the "PLMS» provides the customer with data which give access to both resources and services of pedagogical follow-up data processing. The principal ones are:

- A module code: a single code of access to the module concerned. According to the different cases, this module code will be able to be multi-user and will allow the launching of several sessions by different learners.
- An external address of access to the pedagogical module.
- A return code: a code which indicates the restitution method of the pedagogical follow-up data. According to the different cases, these data could be processed by the customer system or the provider system which offers standard services.
- An access address to the pedagogical follow-up services: the access address to the services of pedagogical follow-up data processing.

This information can be provided to the customer system in the shape of a Web component to the XML format which can be integrated directly at the level of the customer system for the course and pedagogical follow-up data. The corresponding files can be hosed anywhere and passed in parameter of the access address to the provider system services. A provider system and its customer use open protocols such as SOAP, WSDL or the data transmission with forms. The external access to a pedagogical resource by a customer system is carried out by using an open protocol of data exchange between the two systems. It requires the transmission of the following data: the access address to the pedagogical module, the pedagogical module code and the user code.

With the launching of each pedagogical module, the provider system requests the pedagogical module code and an additional user code making it possible to distinguish the users. If this user code is not recognized by the provider system, a dynamic system of user's management generates an anonymous user if there is still an available number in the range of the numbers allocated to the customer. The pedagogical module address is a virtual address protected provided in the file from description of exchange data. According to the customer used, the user code can be generated in a dynamic way.

Mechanisms of learning course management

The term "learning course" indicates here the follow-up (or feedback) of the activities and the results of training of learner. It includes/understands the follow-up of the pedagogical modules carried out, time spent, the number of times that the learner required the tutor solicited, results with the tests. Within the framework of a teaching solution, this course could be personalized according to the progress of the learner. In the learning course, the follow-up data are generated and managed by the provider system. Two cases of figure are possible.

No assumption of responsibility of the follow-up data by the customer system.
If the customer system cannot deal with the management of the follow-up data, these data are recorded in a data base of the provider system which provides, in addition to the data, the services of access to the follow-up data (services of presentation, statistical office, etc.). The access to the data and the services is done according to the same protocol. When one is interested in a particular user, one can specify his user code.

Assumption of responsibility of the follow-up data by the customer system.
In this case, the customer system has his own modules of data processing, these data are provided to him in progress and especially at the end of a learning session according to the protocol of data transmission desired by the customer: XML format according to a predefined exploitable diagram by the customer, transmission by data form.

IMPLEMENTATION OF THE MODEL

Now we will focus on the implementation of the model which we have just described. The first implementation of this model is made to extend the capacities of opening SERPOLET [14] and COGNIFER [1], two collaborative and multilingual learning management systems. These two systems use the same type of management. We will thus just only describe the SERPOLET system which led, within the framework of the development of the Campus Numériques Francophones, to the development of COGNIFER.

Unfolding of a pedagogical module in SERPOLET

SERPOLET [14] is a learning management system offering an authoring system SERPOLET AUTHOR allowing the creation of the pedagogical resources and a learning management system SERPOLET

ADMINISTRATOR. Its complete learning life cycle describes the process in five principal phases : the creation phase, the orientation and planning phase, the training phase, the follow-up and evaluation phase, and the management phase.

Thus pedagogical follow-up constitutes a significant point in this general learning life cycle. It is done during the training phase. It is possible to trace the pedagogical activity during training and to recover the data on activities. A communication mechanism between the pedagogical module and the learning management system allows access and follow-up data exchange between the two entities.

During the launching of a pedagogical module, the learning management system checks if it is about a first use of this pedagogical module for the user profile concerned. If it is not a first use, the learning management system communicates to the pedagogical module the data necessary to the local reconstitution of the training environment corresponding to the last session. If it is about a first use, the environment to be considered will be that generated locally by the pedagogical module.

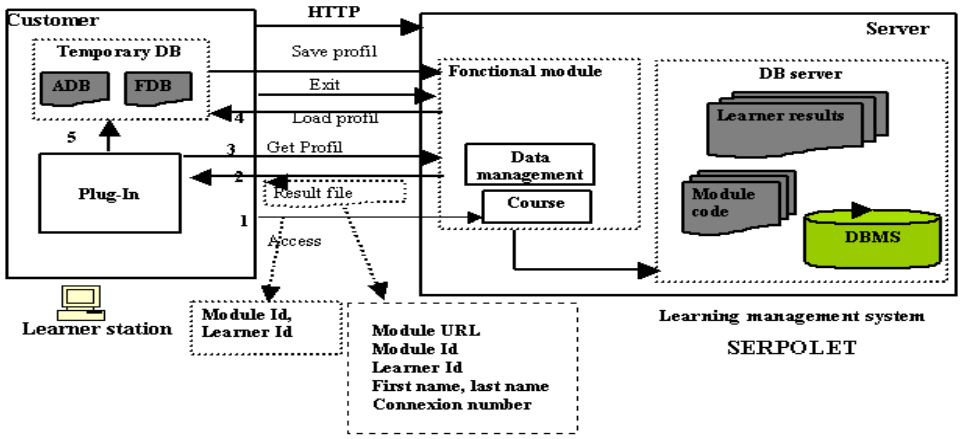

Figure 2 Unfolding of a pedagogical module and pedagogical courses management in SERPOLET.

On the diagrams 2 and 3, ADB and FDB respectively indicate the the assets data base and facts data bases of learning. The numbers indicate the order in which the operations are carried out, of launching until the end of the unfolding of the module.

Mechanisms of content management

Each pedagogical module declared is equipped with a single code, a virtual address of external access and with a return code which specifies the manner of recovering the follow-up data.

Figure 3 shows clearly that the customer station passes by the customer system to reach the pedagogical modules. Once the pedagogical module has been launched, the customer can continue to communicate with the provider system in an independent way. For an external access to the pedagogical module, the customer must provide the three data described previously in addition to the user code which allows a personalized pedagogical follow-up data management.

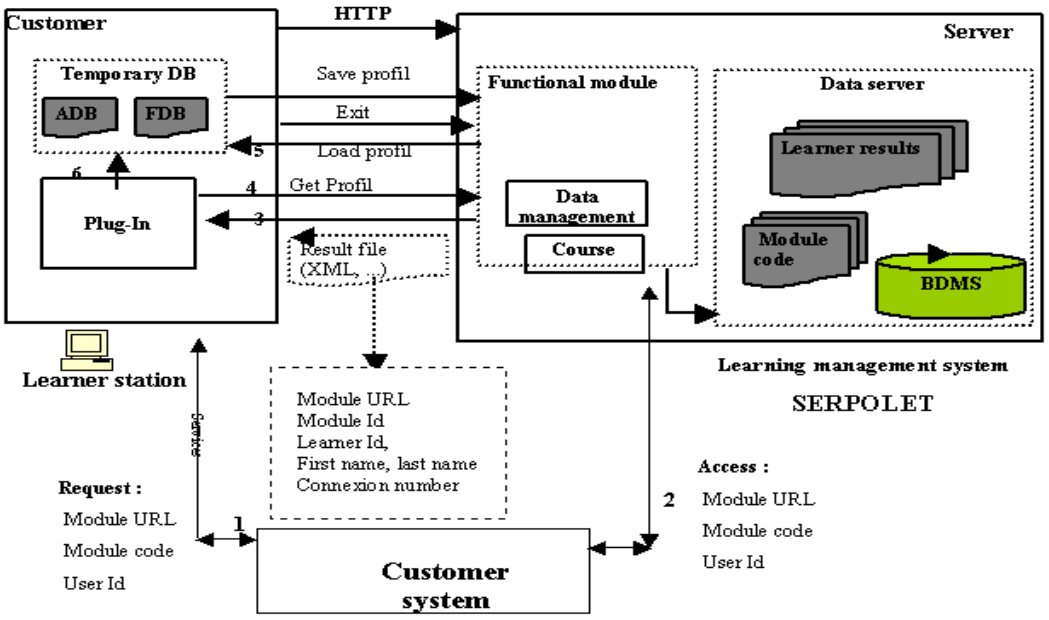

Figure 3. Access protocol to the pedagogical modules.

Mechanisms of training course management

The pedagogical follow-up data are managed either at the level of the provider system or provided rough to the customer system. In the first case, the «Application Service Provider System (ASP System)" offers additional services of access to the results (presentation, statistics...). In the second case, the data are provided rough to the customer system in a standard format (XML). In certain cases, the file of data exchange can be generated by the module during its unfolding.

After having shown how to establish the model of provider system on the learning management system SERPOLET [14] in the case of two particular services, we will show how to generalize this approach.

Integration service of a "virtual classroom"

In the first two examples of services, we have detailed the services that the SERPOLET system can provide to other external systems. In this example (Figure 4), we detail the implementation of an external service by our system. This is the use of a virtual classroom developed by the HP company. The implementation of this example is part of a project to test the possibility of adapting the features of the SERPOLET management platform to the well-specified needs of HP France.

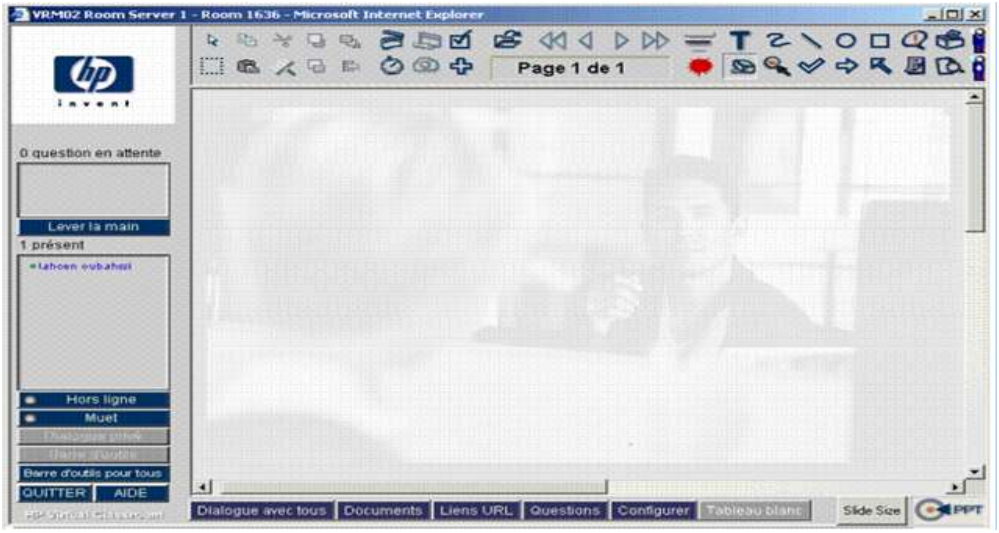

Figure 4 Interface of a virtual classroom.

We first note that a virtual classroom is a component that provides a classroom-like environment in which the teacher can meet remotely with his or her learners to do a training. This environment has a set of tools and features that allow a teacher to effectively conduct their online training sessions. The diagram below shows the interface of the virtual classroom.

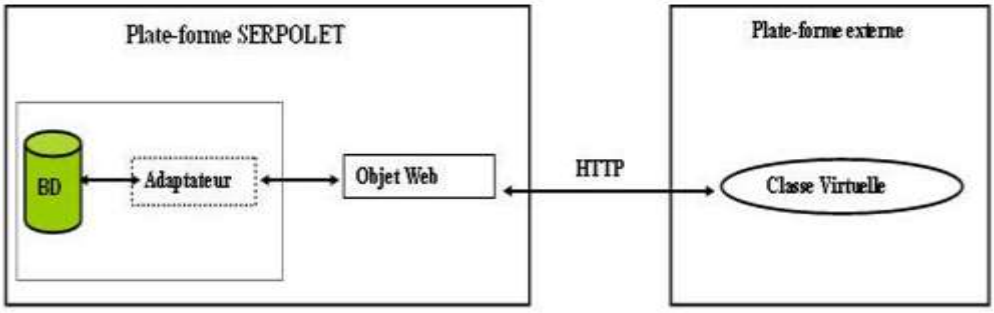

Figure 5 Communication between the SERPOLET system and the virtual classroom.

The implementation of this service on our platform is carried out in two stages. At first, we installed a web object on the server of our system. Then, in a second step, we developed an adapter that allows communication between the system and the virtual classroom via the web object. This adapter makes it possible to transmit the technical parameters necessary for the web object. To establish communication with the virtual classroom, the adapter sends the following data: Last name, first and last user type, password, component version, language, organization id, and virtual class URL. Figure 5 below shows the operating principle between the SERPOLET system and the virtualclassroom.

In this example, we find the operating principle of an application service provider system presented in the two previous examples.

EXTENSION OF THE MODEL

Interaction between "application service provider systems"

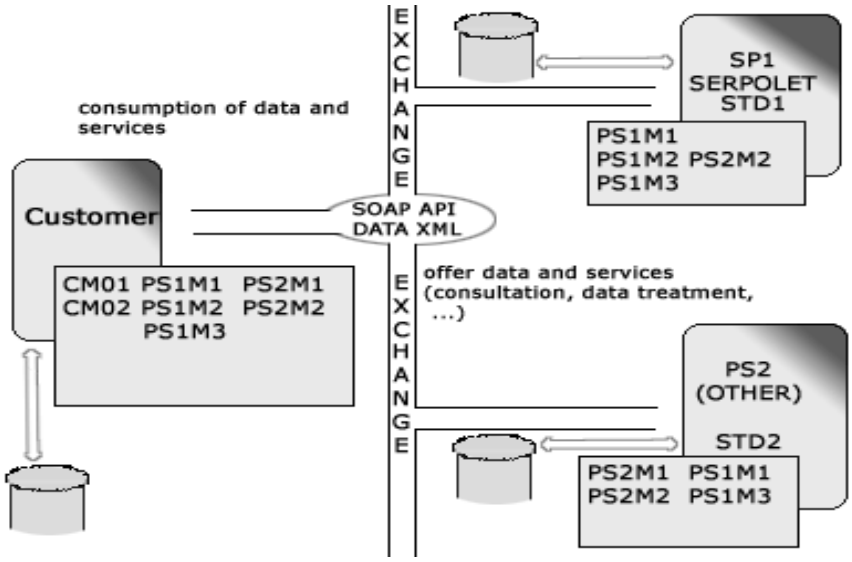

Figure 6 Interactions between systems in a heterogeneous environment.

To extend our model, we consider here the interaction of two provider systems SP1 and SP2 which intends to divide contents without adapting them and without changing the place of hosting. System SP1 proposes the training offer made up of pedagogical modules SP1M1, SP1M2, SP1M3. System SP2 proposes the training offer made up of pedagogical modules SP2M1, SP2M2. SP1 wishes to extend its offer by renting pedagogical module SP2M2 of SP2. SP2 in its turn wishes to extend its offer with pedagogical modules SP1M1 and SP1M3. To supplement our diagram, we also will consider a customer system which wishes to integrate in its training offer {CLM01, CLM02} the pedagogical modules proposed by the provider systems SP1 and SP2.

In figure 6, SPj indicates the provider system SPj and SPjMi indicates a pedagogical module provided by the provider system SPj. This figure summarizes the general situation showing the interactions between systems. Systems SP1 and SP2 can thus share not only their pedagogical resources, but also the services of data processing such as those described previously. Other customer systems can reach it without buying nor renting one of the two systems.

Make standards cohabit or choose a standard?

As we have already underlined, the development, by way of consensus, of international specifications covering technologies of the Open and Distance Learning is within the hands of the ISO (ISO group: IEC JTC1/SC36 [15]). But one is still far from speaking about "standard". For lack of consensus, currently, the problem arises in terms of choice of standards to respect or to adopt. Thus, the respect or the adoption of a standard is today a significant

criterion at the time of the choice of a learning management system, and it also a guarantee of opening and duration. The choice of a standard generally excludes any possibility of interacting with other standards, and thus the use of the contents and systems which are compatible there.

For lack of consensus and homogeneity of the offer on the market, this choice is sometimes painful. Several learning resources –some of which are of very good quality- being still dependent on the learning management systems and the standards chosen, this choice excludes their use or obliges their adaptation. The interconnection of the provider system makes it possible to create a heterogeneous environment supporting several standards, being supported by these provider systems.

In Figure 4, we showed that it is thus possible that system SP1 integrates a standard STD1 (example SCORM) and system SP2 integrates another standard STD2 (example AICC) and that the systems share resources and services.

Serpolet versus xAPI : evolution and convergence

xAPI breaks deeply with SCORM by introducing a new approach and new concepts. These concepts are the basic ingredients for designing new educational solutions through xAPI. Intrinsically, Serpolet already incorporates many of these ideas into other forms. According to [30], in the months or years to come, xAPI will gradually replace SCORM. But it is not a simple technical evolution. This is the way we deploy and follow the training that will change. In its design, Serpolet already adopts several principles of xAPI for which we wish to deepen our reflection on the convergence of the two approaches. The main developments that xAPI proposes are the following:

Evolution # 1: The contents come out of the browser: with SCORM, the contents had to be played in a browser to be able to follow the learner. xAPI removes this constraint since content can now be deployed and played anywhere. Serpolet already offers this possibility since the multimedia contents can also be played off the browser, while keeping track of the learner. Subsequently, Serpolet's interoperability services make it possible to integrate tracking traces into the platform.

Evolution # 2 With or without connection: With SCORM, a connection was required from the opening until the closing of the content. With xAPI, this connection can now be intermittent or deferred. With Serpolet, the services of management of the traces, reinforced by the services of synchronization, make it possible to obtain this result. It is therefore possible to learn offline and use the synchronization mechanism later to communicate the collected information to the platform.

Evolution # 3: More than content: applications. Unlike SCORM, xAPI does not limit itself to plotting the consultation of contents. From now on, any type of application can transmit learning traces: PC-based programs, mobile "Apps", online applications, etc. Thanks to its interoperability services, Serpolet already offers opportunities for openness and communication with external environments.

Evolution # 4: Follow any educational act. xAPI is not limited to monitoring SCORM data: time spent, completion, score, etc. xAPI can trace any educational event: attendance at a course, sharing a document, writing a comment, etc. And you define the actions you want to follow. Serpolet offers the possibility to manage the parameters as tracking variables. However, to facilitate management, a rapprochement effort remains to be made.

Evolution # 5: Follow individuals, but also teams. SCORM traced the consultation of the content, which is in itself an individual activity. With xAPI, any type of activity can now be traced, including group activities: a group assignment, a group project, a group simulation, a group project, a team simulation, etc. Serpolet does not limit itself to individual monitoring, but also offers management and monitoring services for groups of learners. However, the data consolidation services are still very basic.

Evolution # 6: Mediated tracking. With xAPI, it is possible to follow events, but also to record traces in any numeric form. It is thus possible to use sound or video recordings as a learning trace. Serpolet allows the

management of traces in all forms, but only by making the support available to tutors, without making use of it. On the other hand, Serpolet makes it possible to trace in the form of events the activity of a learner inside the sound or video recordings (to play, advance, to back down, to pause, to stop, click, double-click, to select, etc.).

Evolution # 7: Follow any event. xAPI is not limited to the monitoring of pedagogical acts. Any event related to the life of the learner can be traced, if desired. Through experience, results acquired in the field, in a professional situation, can complement a learner's follow-up. This vision is completely integrated intrinsically in the design of Serpolet, but in a global way. This is handled in Serpolet as events associated with tracking variables.

Evolution # 8: With or without an LMS platform. With xAPI, you can follow educational activities without LMS. Indeed, the recording and the restitution of the learning traces is no longer the responsibility of the LMS, but of an independent system called LRS (Learning Record Store). An LRS can be used alone or with an LMS. Serpolet is a modular platform in which the recording and retrieval of learning traces is a component that communicates with other components to share information. In a more evolved vision, the service approach adopted reinforces this character. This learning monitoring component is a sort of LRS that Serpolet already offers in an integrated way to the LMS or as a stand-alone service for the monitoring of learning.

Evolution # 9: An educational ecosystem. Thanks to the LRS principle, learning traces are no longer trapped in LMS. They can flow from one system to another and be consolidated in general dashboards. You can imagine more flexible teaching devices, composed of several integrated systems: several LMS, social networks, blogs, etc. The provider system dimension of Serpolet has been introduced to meet this need. But, in general, to favor this opening. The recovery of these ideas in xAPI gives us a new motivation to go even further in this direction.

Evolution # 10: A personal ecosystem. We all use several systems to train us throughout life: at school, at work, in evening classes, and so on. We change jobs and sometimes resume our studies. By decompartmentalizing the training platforms, xAPI provides a personal response to learning monitoring: Portfolio, PLE (Personal Learning Environment), etc. The opening of Serpolet makes it easy to go to this ecosystem.

To conclude on this rapid comparative analysis, although there are several elements of reconciliation between Serpolet and xAPI and it is clear that many of these principles are integrated in the design of Serpolet itself intrinsically, our future work will devote important place for in-depth analysis and convergence study of principles between the two approaches. It is not a matter of aligning with xAPI, but of creating natural bridges.

CONCLUSION AND PROSPECTS

Faced with the global solution of services offered by the learning management systems and with the lack of consensus and the absence of a "standard" adopted by all, the objective of this study was to propose a new solution of interoperability of the contents and systems as well as a new framework oriented towards the opening of learning management.

The Application Service Provider System (ASP System) model that we have just proposed is intended to facilitate the opening of the learning management systems and consequently that of the market which these tools constitute. This model should contribute to the opening of the learning management environments and provide more data exchanges and services between learning management systems. This opening does not impair the efforts carried out around the development of the standards or the interoperability of the contents and of the systems. On the contrary, it allows these standards to cohabit within a heterogeneous device while waiting for a general consensus which will perhaps lead to the development of a common standard.

The ASP made it possible for companies to use software that they could not install or host in their walls or integrate in their technology for lack of time and money. Likewise, the "Application Service Provider Systems (ASP Systems)" provide companies with an economic model which is both open and flexible, thus allowing them to be able to use pedagogical resources effectively internally or externally.

A "Application Service Provider System (ASP System)" has the economic advantage to resort only to services that are necessary and to give a good financial visibility. For the implementation of the model, we based our research on the Web services and standard protocols used on the Web to extend the capacities of the opening of the learning management systems SERPOLET [14] and COGNIFER [1]. We consider the experimentation of the extended model by proposing partnerships of exchanges to other editors of learning management systems.

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