EducaNext: A Framework for Sharing Live Educational Resources with Isabel[1]

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ABSTRACT

EducaNext is an educational mediator created within the UNIVERSAL IST Project which supports both, the exchange of reusable educational materials based on open standards, as well as the collaboration of educators over the network in the realization of educational activities. The Isabel CSCW application is a group collaboration tool for the Internet supporting audience interconnection over the network, such as distributed classrooms, conferences or meetings. This paper describes the conclusions and feedback obtained from the integration of Isabel into EducaNext, it's use for the realization of collaborative educational activities involving distributed classrooms, lectures or workshops, as well as the general conclusions obtained about the integration of synchronous collaboration applications into educational mediators.

Categories and Subject Descriptors

H.4.3 [**Communication Applications**]: Computer conferencing, teleconferencing, and videoconferencing – *videoconferencing platform construction based on brokerage.*

K.3.1 [**Computer Uses in Education**]: Collaborative Learning, Distance Learning.

General Terms

Design, Experimentation, Standardization.

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Keywords

EducaNext, Educational Mediators, Learning resource, LOM IEEE Standard, Videoconferencing, Live collaboration over the Internet, Educational Activity, Isabel Application.

1. INTRODUCTION

The use of information and communication technologies, such as the broadband Internet, enables new forms of collaboration among educational institutions which may increase the overall effectiveness of the educational system. On the other hand, despite the strong interest raised by e-learning, the core of the educational system is still based on presential education, probably because of the higher effectiveness of the school paradigm as compared to self study or tutored approaches. Therefore the use of information and communication technologies supporting or complementing presential education, which can be considered as a variety of "blended learning", is considered each time more as a key element of the education of the future.

The present LOM (Learning Object Metadata) models [18] are more applicable to self study approaches than to presential education environments. More refined models which are capable of covering selfstudy approaches, tutored learning, as well as presential education need to identify at least two types of learning resources, educational materials and educational activities as given in [1], to properly model the elements and processes taking place.

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The term "educational material" is used in [1] to denote all units of content that can be stored and transferred in digital or non-digital form. These content units are somehow static in the sense that they are produced to be (re-)used by persons who rely on this type of learning resources in order to deliver education. The "educational material" category includes not only books and other reading material, but also courses or lectures recorded on video tapes, learning management systems or multimedia CD-ROMs, because they are used by educators to support their instructional activities.

The term "educational activity" is used in [1] to denote events where educators and learners work on the enhancement of knowledge or skills. Hence, an educational activity is a service that is provided in order to support the accomplishment of a specific educational objective. This is achieved by creating a learning environment consisting of educators, educational material, communication infrastructure, meeting places, etc.

Educational mediators [3, 5, 8, 9, 10, 11, 12] exchange usually educational objects, which are also referred to as packaged content, which is aimed at supporting learners in their learning process or at supporting educators in the learning activities under their control. This paper focuses on EducaNext an educational mediator which goes one step further and supports not only the exchange of learning materials, but also the exchange of learning or educational activities over the network.

EducaNext is an educational mediator created within the UNIVERSAL IST Project [3, 5, 7] which supports both, the exchange of reusable educational materials based on open standards [2], as well as the collaboration of educators over the network in the realization of educational activities [1].

Today's availability of broadband networks and applications allows an effective sharing of educational activities in synchronous collaborations over the Internet with advanced collaboration applications, such as videoconferencing, remote presentation, as well as other types of collaborations tools.

The Isabel CSCW application (http://isabel.dit.upm.es) [13, 14] is a group collaboration tool for the Internet, which supports audience interconnection over the network, such as distributed classrooms, conferences or meetings, where participants interact in properly set-up rooms or auditoriums. This paper describes the conclusions and feedback obtained from the integration of Isabel into EducaNext, it's use for the realization of collaborative educational activities involving distributed classrooms, lectures or workshops, as well as the general conclusions obtained about the integration of synchronous collaboration applications into educational mediators.

2. EDUCANEXT

The EducaNext (http://www.educanext.org) service aims at increasing the excellence of higher education and research by means of the collaborative creation, exchange and reuse of learning and knowledge resources among the members of the academic community.

The service has been created with a multilingual collaboration portal where the members of higher education, research or professional institutions can register and become members of the *EducaNext Community*. The *Mission* and *Code of Behaviour* of EducaNext must be explicitly accepted by community members when registering to assure a fair reuse of resources.

The members of the EducaNext community are entitled to perform the following functions:

- Proposal and creation of new *Knowledge Communities*
- Registration and participation in knowledge communities to contact or collaborate with experts in the knowledge area of the community
- Exchange *Learning Materials*, such as electronic textbooks, recorded lectures, presentations, lecture notes, case studies, quizzes, etc.
- Deliver distributed *Educational Activities*, such as distributed courses, lectures, tutoring sessions, workshops, congresses, etc.
- Distribute the electronic content offered under several kinds of licenses, including licenses for free distribution, academic distribution, academic distribution with no modifications allowed, tailored license, etc.
- Collaborate on the production of knowledge and learning resources.

A community of content producers shall make use of those services to produce, share and maintain a repository of high quality resources, which are assessed, evaluated and rated by consumers or selected reviewers. Quality is a prime concern in the service design and several procedures for quality control have been introduced, which cover educational material as well as activities.

3. THE UBP ARCHITECTURE

EducaNext has been implemented with the UBP (UNIVERSAL Brokerage Platform) [5] developed within the Universal IST Project. The UBP is an open platform which has the goal of allowing the integration of users, as well as learning resource offers or even existing learning resource repositories.

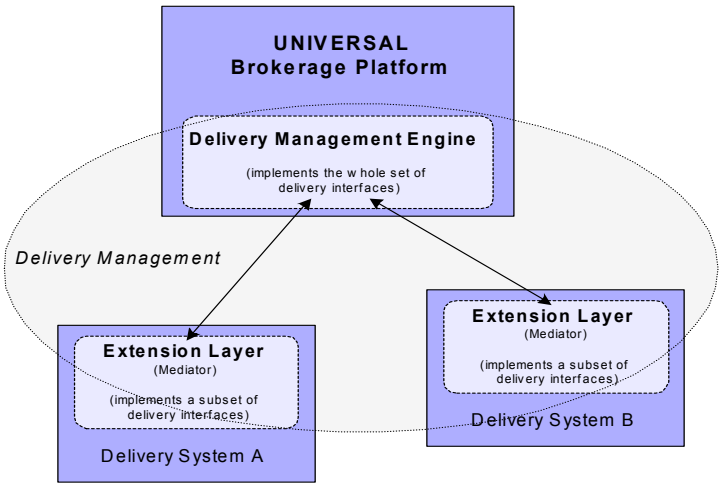

Figure 1. Service Architecture

The design has been therefore based in open standards, such as, XML/RDF metadata representations of the learning resource offers, SOAP interfaces for communication or URN for object references. The IEEE LOM standard [14] has been used for metadata representation, although extensions have been necessary to support the representation of educational activities [1]. Offers describe and link resources available over the Internet, which have been made by members of EducaNext and which may be

booked by other members of EducaNext. The learning object metadata are represented in XML/RDF, in order to make the UBP an early example of the W3C Semantic Web initiative.

The model of educational activities used includes the elements needed for the organization and management of offers, bookings and deliveries over the UBP, namelly:

- Educational elements, such as the educational objective and the support material used (textbooks, slides, etc.).
- Educators involved, such as professors, tutors, etc.
- A schedule indicating the exact time frame when the activity will take place.
- The delivery platform which in our case is an Isabel delivery platform which connects the activity provider with the activity consumers.

In order to decouple the brokering functions from the content delivery functions, the UBP includes a generic delivery interface for the integration of third party content delivery servers or platforms. This interface is based in SOAP and is known as the DME (Delivery Management Engine). It has been designed to interface with educational resources stored in repositories or LMS (Learning Management Systems), as well as with synchronous delivery platforms for the delivery of learning activities. This architecture creates a two-layer system where the upper layer deals only with brokerage of learning object metadata, whereas the lower layer deals with real learning resource delivery, as shown in Figure 1.

The DME interface has the following functionality:

- Check availability of system and delivery requirements.
- Grant, Deny and Check security access for a user.
- Check the availability of a Learning Resource.
- Report each delivery of the Learning Resources from the delivery system over the DME in order to allow billing.

The following delivery platforms have been integrated in the UBP in the UNIVERSAL project:

- LMS: Hyperwave, AllWeb, IMC
- Web repositories: Apache Server
- Audio/video streaming: Real server
- Video conferencing and CSCW: the Isabel application

This paper describes the architeture designed for the integration of delivery platforms for educational activities over real time collaboration systems such as the Isabel CSCW application, MBONE tools, H320/H323 or SIP videoconferencing, etc. The Isabel CSCW application [13, 14] has been chosen for live delivery of UBP events because it provides support for interactive interconection of audiences in a multipoint scenario, enabling the realization of various types of collaborative activities over the network which are very common in academic environments, such classes, seminars, meetings, etc. The participants had also access to the source code for doing adaptations and changes in the application. The results obtained can be easily generalized to other live delivery platforms.

Figure 2. Captures of various Isabel interaction modes

4. BROKERAGE OF EDUCATIONAL ACTIVITIES

The Isabel CSCW application [13, 14] is a group collaboration tool for the Internet, supporting synchronous collaborations which involve audience interconnection in distributed classrooms, conferences or meetings. Isabel has been designed to support participation in properly set-up rooms or auditoriums, although it

can be also used from the desktop. Isabel may have therefore two types of access requests in bookings:

- Interconection of rooms for audience interconnection.
- Participation of individual persons from a desktop.

Providers will have to specify in the offer if the educational activity is for audience interconnection, individual access from the desktop or both. Consumers booking the offer will have also to specify the type of access to be booked. For example, booking for audience interconnection can be performed by a professor willing to involve his students in a distributed course delivered by another institution or in collaboration among participants, whereas booking for desktop access will be performed by individual persons willing to attend the educational activities themselves and may have interactive or passive access.

The service used in the activity must also be specified in the offer. Isabel is a meta-application where services can be defined. Each service supports a given type of collaboration, for example

- The tele-class service has been designed to allow a strict control by the lecturer or educator of the interactions taking place. The service mimics in a distributed environment the interactions taking place in the classroom. This service is typically used in distributed courses among institutions.
- The tele-meeting service has been designed to allow a fairly free way of interacting, allowing each participating site to select at any time an interaction mode. This service needs a very disciplined audience where participants do not interrupt others in an impolite way.
- The tele-conference service has been designed for program driven events, such as distributed congresses or workshops, which must follow a very strict schedule and planning. The service is therefore script driven and with centralized control.

Each service is composed of a set of *interaction modes* which are selected and controlled by a given *floor control* framework. In a distributed session many different types of interactions have to be made, for example, a lecture, a slides based presentation, gathering of remote questions, a distribute demonstration, a distributed panel session with questions, etc. Each *interaction mode* supports one of these collaborative interactions, providing a particular configuration of the shared media, such as audio, video, slides, applications, pointers, etc.

Figure 2 depicts several snapshots of collaborative activities performed in UNIVERSAL over EducaNext involving audience interconnection. Each snapshot shows a given interaction mode at some point of the session, such as a view of all the sites, a video based talk, a chat, a slide show, etc.

5. DELIVERY PLATFORM FOR EDUCATIONAL ACTIVITIES

The second dimension of Isabel collaborations is the delivery platform which must be created for the delivery of educational activities. Each EducaNext offer may be booked by different consumers and therefore each delivery may need a different delivery platform. Isabel platforms are constructed over IP networks with the following ellements:

- A *session master* which coordinates the conference.
- A set of *interactive terminals*, which are the connection points of the access rooms in the sites to the session.
- *Flow servers* which have several functions for linking the terminals to the session, such as service proxy, multipoint unit, media gateway, etc.
- The *Web antenna* for performing a webcast of the session to standard Web browsers.
- The *session recorder* which records the session in high resolution video in MPEG4 format.

The communication in the Isabel session uses UDP and TCP as follows:

1. The management agent of the Isabel terminal connects to the Master site with a TCP connection. The Flowservers act as TCP proxies.
2. The media components are exchanged between the Isabel terminals as UDP Datagram flows. The UDP flows of the media components are aggregated the flow-server. The UDP flows can be exchanged over unicast or multicast.

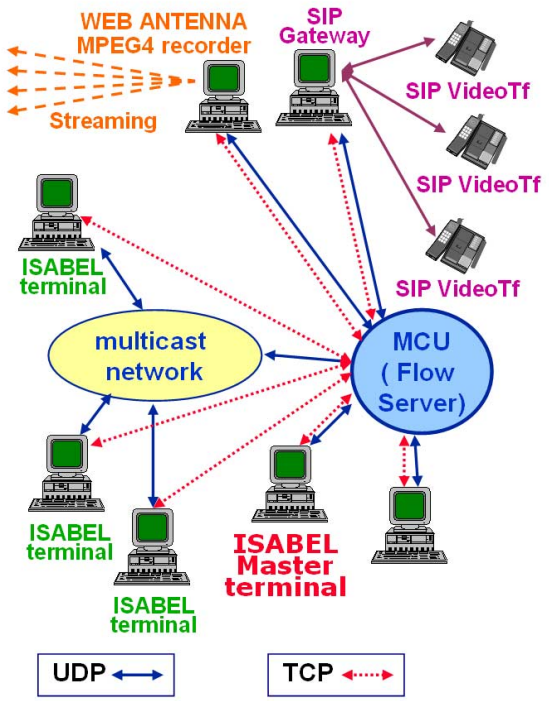

Figure 3. An Example of an Isabel Delivery Platform

An Isabel session is coordinated by the session master which acts also as the entry point for the rest of the Isabel terminals to the session. The participating Isabel terminals must submit a request to the master, either directly or via a flowserver acting as proxy, to get the acceptance into the session. After getting the acceptance, the terminal will enter the session configured with the service defined by the master for this session.

The Flowserver is the central ellement for assembling platforms. It allows Isabel platforms to adapt to the connectivity problems existing in today's Internet where the "end to end" connectivity does not exist, where isolated multicast islands exist, etc. The main functions are

- Service proxy function which allows the access of a participant to the session through a unique entry point, which is IP reachable from his site.
- MCU (Multipoint Control Unit) function for setting up multipoint configurations over IP unicast.
- Gateway function which allows to connect IP multicast with IP unicast subnetworks, as well as VPNs with private addressing with the public Internet.
- Traffic shapping and limiting function which performs a compatible merge of the multiple RTP media flows.

Each Isabel interactive terminal includes a flowserver inside and can be used as a service proxy for other participants. Nevertheless dedicated flow servers are recommended because they provide an always on entry point to sessions.

Figure 3 depicts an example of delivery platform. The platform includes a variety of different ellements to illustrate the variety of choices which the offer and booking process may face.

The example includes 3 types of consumers, having each different requirements, as well as a different type of connectivity to the platform. The 3 types of consumers are:

1. *Interactive audience participation:* needs a properly set up room with audiovisuals. An Isabel interactive terminal will connect the room to the platform. Interactive terminals must reach the master from the multicast zone of the figure, as well as via a flow server which is acting as an access proxy.
2. *Interactive individual participation:* persons accessing the session from his desktop by means of the SIP gateway (or similar), who would like to be able to ask questions via voice, chat, etc.
3. *Passive individual participation:* persons accessing the session from his desktop by means of the Web antenna (or similar), who is interested only in receiving the session.

The platform includes also a video recorder to package the session which may be offered later as educational material in Educanext.

This example illustrates the requirements imposed on the brockerage process, as well as on the delivery service, because each educational activity needs a delivery platform which is able to deliver all the requested bookings.

The generic requirements for a seamless integration of brokerage and delivery can be summarized as follows:

- The brokerage platform must provide the various types of bookings required by potential customers.
- The brokerage platform must acquire during the brokerage all the necessary information and enablers for setting up the delivery platform.
- The brokerage platform should, ideally, be able to automatically configure the delivery platform and deliver to all consumers the booked delivery on schedule.

This requirements are difficult to meet 100% with todays technology which does not allow the complete automation of this process in the general case. The next chapters describe the integration between brokerage and delivery made in the Universal project, as well as the degree to which those requirements have been fulfilled.

6. MANAGING ISABEL SESSIONS WITH THE UBP

The UBP architecture has two layers, the brokerage layer and the delivery layer. The upper brokerage layer deals only with brokerage of learning object metadata, whereas the lower delivery layer deals with real learning resource delivery.

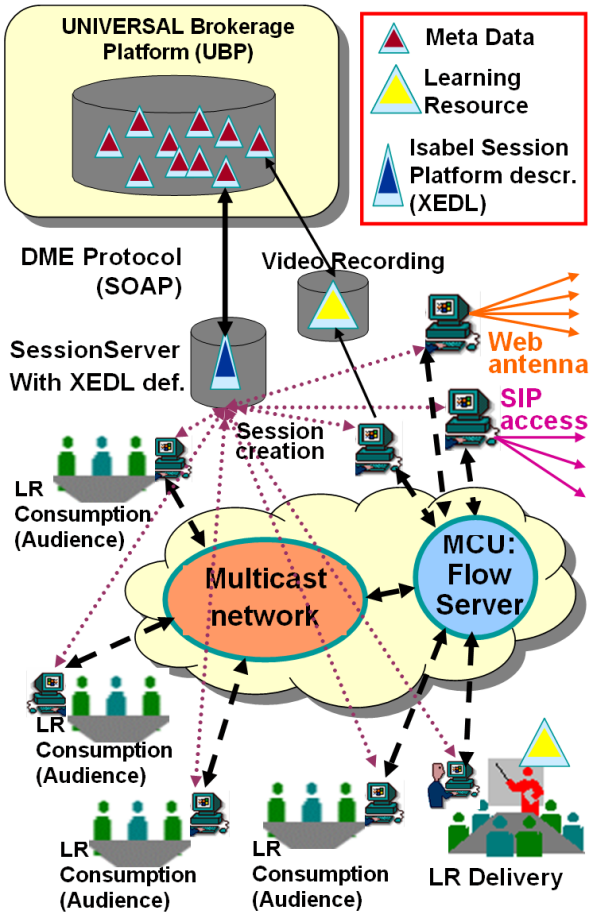

Figure 4. DME for Isabel sessions

The brokerage layer must deal only with the concepts and data relevant for the creation of metadata, abstracting from all the delivery platform implementation details. Therefore the integration of Isabel into the UBP includes a session server which deals with all delivery platform implementation details.

Figure 4 illustrates the details of the DME architecture where the UBP interfaces with the Isabel session server in order to establish the relation between the bookings made of the offer and the

platform needed for the delivery of the educational activity. The creation of the session will be managed by the Isabel session server.

The creation of the LR offer at the brokerage level will create an associated delivery platform defintion in the session server which includes only the session parameters, the providing site and the generic servers used for the delivery, such as flow servers, master, recorder, web antenna, SIP gateway, etc. Each booking will include a new site in the platform definition of the session server associated to the EducaNext user performing the booking. Only the bookings registered in the session server will be allowed to enter the videoconferencing session. The exact topology of the platform will not be known until all the bookings have been made.

As network bandwidth and connectivity impose a lot of restrictions in videoconferencing platforms, session managers will usually tune the final definition of the platform topology when all bookings have been made in order to make the best use of the network resources. A completely automatic generation of the platform is not possible in the Internet today due to the lack of bandwidth and "end to end" connectivity in the Internet today.

To support the incremental definition of the session platform, a platform description language has been designed in XML which has been called XEDL (XML sEssion Definition Language). The language allows incremental definition of platforms, such that when the offer is made a first definition of the platform is created which includes only the general session parameters and servers. Each time a booking is made a new version of the platform definition is automatically generated which includes the new site in the platform definition.

The access to the session includes authentication of consumers as defined during the booking process. Therefore only the sites which have booked the LR are allowed to enter the session where the real delivery is taking place. Individualized access control is only managed for sites interconnecting rooms and audiences. For individual access from the desktop as provided by the Web Antenna or the SIP gateway access is managed at the access point of the servers directly.

The existance of a precise Isabel delivery platform definition which contains all the necessary information for launching the platform has allowed the development of a remote platform launcher which enables the remote launch of all the ellements of the platform by a remote control center or automatically by the session server before the session start, simplifying the session operation very much.

When a session includes various types of bookings, such as interactive audience participation and passive individual participation, a composite offer can be made over EducaNext which enables booking of the desired access.

6.1 XEDL Platform Descriptions

The eXtensible Markup Language (XML) is a development of the World Wide Web Consortium (W3C) derived from the more complex Standard Generalized Markup Language (SGML), and aimed mainly at structuring data over the web. Like HTML, XML makes use of tags (words bracketed by '<' and '>') and attributes (of the form name="value"). A well-formed XML document creates a tree of tags, each of which can include several attribute-value pairs. An XML Schema [15] has been used to restrict the generic XML markups to the valid XEDL platform definitions which describe a well formed delivery platform. The structure of the highest level of EDL XML Schema definition is shown in Figure 5.

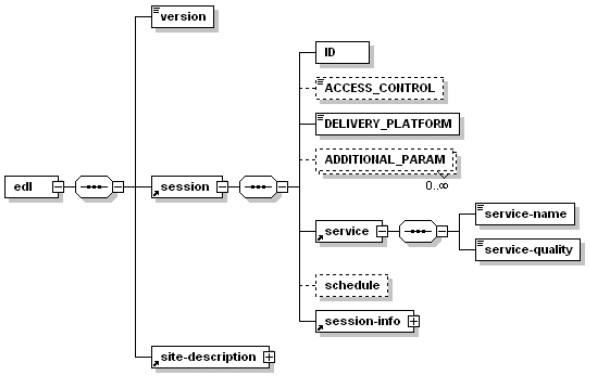

Figure 5. EDL XMLSchema

An XEDL file (XML sEssion Description Language) is composed of a generic session description and a set of participating site descriptions. The generic session description must include all the session parameter as well as the generic elements of the session, such as the master and the Isabel MCU's (Flow Servers) used for the session. Each site must define the type of participation, (interactive or not), the bandwidth and his entry point to the conference which is ussually a flow server.

XEDL is platform-independent, allowing the definition of application and networking platforms. For example, an EDL XML document defining an Isabel tele-meeting conference, etc. would be as follows:

```
<edl xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
                xsi:noNamespaceSchemaLocation="esquemaEDL.xsd">
    <version>1.5</version>
    <session>
        <ID>Universal</ID>
        <DELIVERY_PLATFORM>
            Isabel
        </DELIVERY_PLATFORM>
        <service>
            <service-name>telemeeting</service-name>
            <service-quality>2M</service-quality>
        </service>  ……
        <site> ……..
        </site> ……
    </session>
</edl>
```

6.2 Modelling Platforms in RDF

The Resource Description Framework (RDF) is another World Wide Web Consortium initiative for the representation of semantic properties and relations among Web resources. The basic concept in RDF is that an identifiable, addressable 'resource' may be described by means of a selection of 'properties', each of which has an associated 'value'. These properties may, as well, form, in themselves, another 'resource'.

RDF can also be represented in the form of 3-tuples (triples): {predicate, subject, object}, where predicate is a property, subject is a resource, and object is either a literal or a resource.

RDF properties may be thought of as attributes of resources and, in this sense, used to represent traditional attribute-value pairs. RDF properties also represent relationships between resources.

In the next Figure, an example of an XEDL platform description is described in RDF using a graph

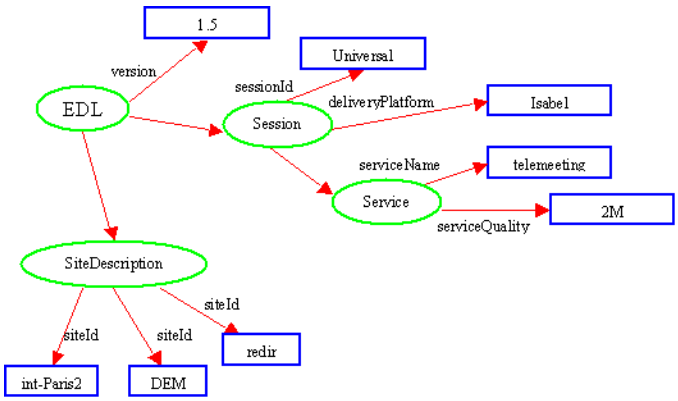

Figure 7. Example of an EDL RDF Document

Where the corresponding triples for the graph above would be

{version, /EDL, 1.5}
{session, /EDL, /EDL/Session}
{sessionId, /EDL/Session, Universal}
{deliveryPlatform, Session, Isabel}
{service, /EDL/Session, /EDL/Session/Service}
{service, /EDL/Session/Service, telemeeting}
{serviceQuality, /EDL/Session/Service, 2M}
{siteDescription, /EDL, /EDL/siteDescription}
{siteDescription, /EDL/siteDescription, redir}
{siteDescription, /EDL/siteDescription, DEM}
{siteDescription, /EDL/siteDescription, int-Paris2}

The compositionality of RDF descriptions is of high value for composing complex platforms out of individual platform component descriptions. The annotation of platform component descriptions with RDF properties allows a straighforward composition of parts and provides a very clear graphical representation of the session platform. Nevertheless, the use of platform component metadata has to be better understood.

7. CONCLUSIONS AND FURTHER WORK

This paper describes the extension of an educational content mediator, the Universal Brokerage Platform, to allow the brokerage of educational activities, which is based on a new taxonomy for learning resources that differentiates "educational activities" from "educational material". This taxonomy has led to an enrichment of the standard LOM metadata model and serves as a vehicle for defining generalized educational offers which should be acquired or consumed by third parties with the help of educational mediators. The model can represent a variety of educational offers available over the Internet, ranging from traditional courses in the classroom to courses over videoconferencing or over learning management systems.

The term "educational activities" is used to refer to events of which the primary goal is to educate and train persons, whereas "educational material" is used to refer to units of content that support educational activities. A clear differentiation between these two categories of learning resources seems necessary for deriving proper exchange models for educational mediators. Besides, we support the argument that educational activities as a special type of learning resource are not sufficiently covered by the IEEE LOM.

The integration of "educational activities" in an educational mediator has been an enriching excercize which has shown the flexibility and apropiatedness of the new Web architecture based on XML for solving complex interconnection problems. XML has provided the means for interconnecting two completely different systems the Universal Brokerage Plaform and the Isabel CSCW application. This has been achieved with XEDL, an XML based language for modelling complex videoconferencing platforms, which provides an easy way for the incremental construction of the delivery platform in each brokerage step carried out by EducaNext users.

The ultimate goal of the integration was the fully automatic generation of the educational activity delivery platform, but the connectivity problems existing in today's Internet do not allow an automatic construction in the general case. The main problems are

- The lack of "end to end" connectivity due to NATs, firewalls, proxies, gateways, etc.
- The lack of sufficient bandwidth, multicast, QoS reservation services, etc.

Those lacks do not allow an automatic platform design which makes an optimal use of the network resources. Nevertheless the use of XEDL provides a very flexible and effective means for the semiautomatic generation of the platform description. The final platform can be manualy optimized with a minimal effort by the platform managers when all the bookings have been made, by taking into account the bandwidth bottlenecks, firewalls, NATs, etc.

XEDL has been even a very effective tool for complex Isabel platform deployments and is used today as the standard procedure for creating Isabel platforms and not only for brokerage of Isabel based educational activities over EducaNext. Although no measures have been taken, the use of XEDL together with the automatic site registration and launch functions which automate the incremental definition and launch of platforms, has reduced platform set up time very much (probably by a factor of more than 2). XEDL has simplified the organization of distributed educational activities, which required before very complex coordination procedures among the site responsibles.

Two research lines are not being carried out as a continuation of this developments. The first line of work is the extention of XEDL to a generic platform definition and deployment language. Many network or application services require a complex set up which has many similarities with Isabel platforms. Therefore an extention of the language is under way to allow the inclusion of new type of platform components and component association types, which will be able to create secure VPNs based on IPsec, QoS reservations, etc. The second line of work is the development of an annotation framework for XEDL platform component definitions with RDF metadata which should allow a more automatic composition of platform ellements in a more open envirnment as the one esxisting today.

The realization of live activities creates also new IPR issues [17]. The live broadcasting of the sessions and the recording and redistribution of the activities need to be addressed in each offer/booking process.

The availability of European broadband networks is a necessary condition for the realization of live experiments. The deployment of GEANT and the improvements taken place during the lifetime of the UNIVERSAL project have greatly simplified the organization of live events at the end of the project, when the broadband European Internet (GEANT + NRENs) where generally available at the participating institutions. This was not the case at the start of the UNIVERSAL project, when the MBS ATM service had to be used.

Isabel has fulfilled the needs of the collaborative educational activities done in the trials. XEDL has also fulfilled the requirements for which it was designed, namely the incremental generation of live platforms according to the offer/booking process of each learning resource brokerage. Although the existing implementation has been validated with Isabel only, it should be easily reusable with other live delivery systems.

Only the fully automated creation of delivery platforms has not been achieved due to the difficulty of optimizing the use of network resources in the present Internet. The deployment of IPv6 which shall restore the "end to end" connectivity in the Internet is very likelly a necessary step to allow such an automatic construction.

8. ACKNOWLEGDEMENTS

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