An Open E-Learning Authoring Environment

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Abstract. The goal of this paper is to propose a complete environment for authoring cooperatively elearning courses using a workflow approach and relying mainly on open software and web standards. This authoring environment is based on modern technologies such as XML, SMIL and WebDAV and allows to connect a group of professionals in order to cooperatively create material for e-learning courses. The proposed environment uses a workflow to control the authoring process and helps coordinating the different tasks involved in the course creation. We show that the use of open software allows the production of a very low cost environment.

1 Introduction

In the current web infrastructure, the creation of quality didactic material remains a difficult task. At the same time, there is a desire to incorporate in e-learning systems multimedia courses in order to make the courses as close as possible to regular lectures. In addition, more and more functions, such as examinations, are to be added to these systems in order to establish a fully functional e-learning environment. This leads to a higher overall complexity of the system and requires more attention to design considerations when attempting to build such systems. One of the aspects that allows reducing this complexity is related to the process of didactic material authoring for e-leaning, what we call in this paper "e-learning authoring". This operation can be more efficiently carried out if it is handled as a cooperative process. In this process, a group of educators and technical people are brought together to design, author and deploy the courses.

Usually, the deployment of e-learning systems involves an important number of users, in particular if the students are expected to connect to the system. Therefore, the system relies on Web technologies deployed at a world wide level. The use of the WWW for training and e-leaning purposes is unquestionable and will grow even more with the advent of newer Web technologies, like XML and SMIL. However, the use of WWW is most of the time limited to carrying information as a medium to present

e-learning information. A better alternative is to use it as an authoring environment, serving not only to connect a group of authors, but also coordinating their activities. This allows benefiting from the technologies, standards and available products on the Web in order to build more efficient e-learning systems. In this paper, we combined some of these available technologies, standards and products to build an experimental open authoring environment for e-learning.

We present in this paper this cooperative authoring environment for e-learning based on the WWW. We purpose the use of modern technologies, like XML, SMIL and WebDAV, and open softwares, like Amaya and Annotea, to create at a low cost a functional environment for e-learning. Moreover, on top of these elements, we propose the use of a workflow engine to control the creation of courses. The workflow allows to guide all the authoring process, while coordinating the cooperation among authors, thus helping the group to efficiently produce their e-learning material.

The proposed environment is divided in four basic elements: a workflow engine that controls the other elements, a web authoring tool, multimedia tools, and a set of functions supporting the cooperative work. These elements interact according to the diagram shown in the Figure 1. The scenario of a session in this system happens as follows: Initially (1), the coordinator of the group defines the workflow for the e-learning authoring process, using a workflow editor. This coordinator submits the workflow description to the server (2). A workflow engine will use this description to control the authoring process. After that, the course authors will be able to follow this process, by interacting with the workflow engine (3), while they are using the tools to create the course's web pages (4) and multimedia resources (5).

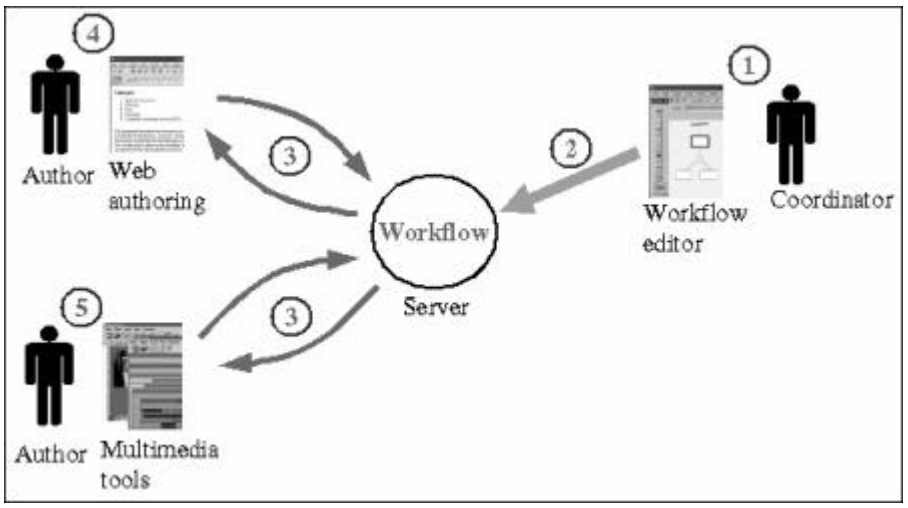

Fig. 1. Overview of the proposed environment.

In the remaining part of this paper, we will describe all of the elements presented in Figure 1 separately. In the Section 2, we show how the web pages serving as course

material are constructed (the web authoring tool). In Section 3, we cover the multimedia production system (the multimedia authoring tools). Section 4 shows the cooperative aspects of the purposed environment. Section 5 presents the workflow engine, which brings together all the elements. Finally, in Section 6, we present some future considerations about the course execution, and in Section 7, conclusions and future work are given.

2 Web Authoring

The first element of the proposed environment is a web editor to create the web pages for our e-learning course. We have chosen Amaya, an open source browser/authoring tool developed by W3C that allows easy publishing of documents on the Web. Amaya is a complete web browsing and authoring environment and comes equipped with a "WYSIWYG" authoring interface, similar to that of the most popular commercial browsers [18]. As it is used by W3C to demonstrate and test new developments in Web technologies, Amaya includes the latest modern features, like XML and CSS. Thus, using Amaya, users can produce pages encoded in HTML and XHTML, generate CSS style sheets, MathML expressions and SVG vector graphics. Consequently, our users can build powerful web pages for their e-learning courses, using a very lightweight tool. Moreover, as Amaya complies with web standards, the produced pages can be viewed thanks to any modern web browser.

Amaya also implements an Annotea client [10], an application for collaborative annotations based on state of the art technologies like RDF and XPointer. Using such a client, users involved in the e-learning authoring process can insert annotations in their courses' documents. The annotations serve as an important cooperative function and a communication channel between the group members. During a course preparation, it allows the insertion and the exchange of comments, ideas, experiences, etc. Complementing this web authoring tool, there should be a well configured HTTP server. This server permits the users to publish their pages and to make these pages available for the co-authors, allowing the construction of the cooperative environment needed for the e-learning authoring process. The same server may also enrich this cooperative environment by the addition of one Annotea server, as we will see in the Section 4.

All these web authoring features proposed in our environment are represented in Figure 2. In this figure, both the client and the server side may be seen. On the client side, there is Amaya, together with Annotea. And on the server side, the Annotea server and a full web server. We have been using Apache as our HTTP server [1]. Apache is a very popular open source server. Apache supports HTTP PUT requests, which allows the users to publish their material, and also support WebDAV requests (see Section 4). Moreover, the W3C's Annotea server is based on the same web server and uses a set of scripts written in Perl and a database called MySQL, both open source tools. Therefore, the overall architecture remains quite standard, portable and available as open source software.

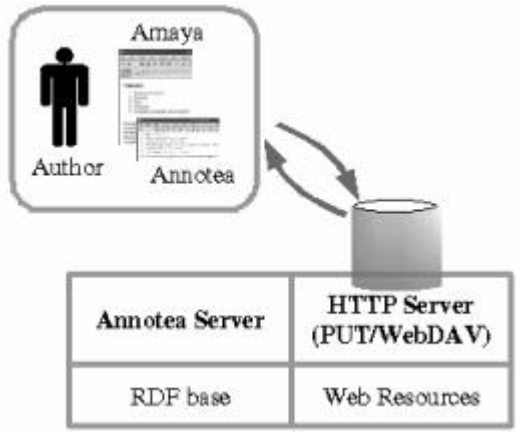

Fig. 2. Web authoring features

3 Multimedia Tools

As we mentioned earlier, the importance of using multimedia for e-learning is unquestionable. There are many tools available to create medias, like images, sounds and videos, and thousands of media files are already available over the Internet. But, putting all medias together in the same document will not help enhancing the course quality. A more useful function is to synchronize these media over time to reflect the temporal arrangement of the content used by teachers, like gestures, demonstrations and examples. In our work, we concentrated in the use of multimedia synchronization tools, which give the authors the possibility to coordinate and construct rich multimedia presentations.

One of the recent standards for multimedia synchronization is the SMIL language. SMIL (Synchronized Multimedia Integration Language) [13] is a XML based language proposed by W3C that permits the integration of different media types, like streaming audio and video, images and text. SMIL enables simple authoring of interactive audiovisual presentations [13]. With SMIL, it is possible also to augment existing languages with synchronization functionality. The result is languages like XHTML+SMIL, which includes a subset of the SMIL 2.0 specification, providing support for animation, content control, media objects, timing and synchronization, and transition effects to XHTML and CSS elements [15].

What we purpose in our environment is to use multimedia authoring tools that support SMIL and SMIL+XHTML documents. These documents could be linked in normal web documents, such as the documents created by Amaya, and rendered by web browsers (like Microsoft Internet Explorer 5.5, that presents XHTML+SMIL2.0) or by its plug ins (like Real Player plug in, in Netscape browser, that presents SMIL1.0). As a consequence, users may add the results of these multimedia

synchronization tools to the documents created by Amaya creating therefore a richer hypermedia documents for the courses.

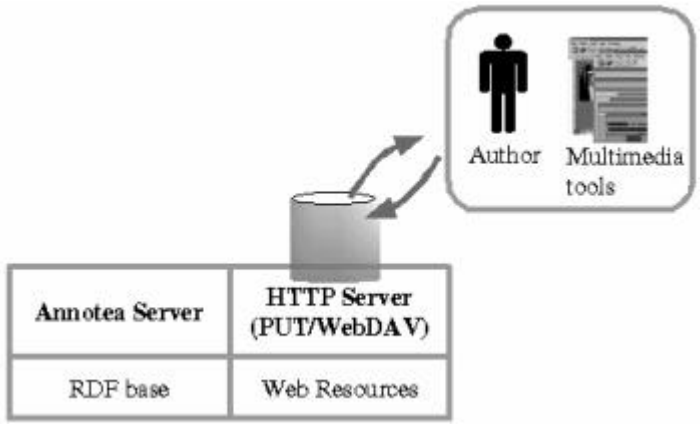

Fig. 3. Multimedia features

Figure 3 shows the interaction of the multimedia tools with the web server, presented in the previous section. The idea here is to keep the produced multimedia resources and files in the same web server where the web pages are stored. Thus, all the e-learning material will be available in a single server, and all authors involved in the authoring process will be able to access and use the available material and collaboratively interact to enhance its content.

The workflow element of the proposed environment, as we will see in Section 5, is the central component for the coordination between the different authors. The workflow allows associating the necessary tools to every task. It drives the authors by notifying them when those multimedia authoring tasks have to take place during the course's production

4 Cooperative features

When working in a group, we expect to develop products with better quality and productivity, through an harmonic and cooperative interaction among the group members [3]. So, in order to integrate this aspect in the e-learning authoring process, we provided some support for groups to cooperatively design and create e-leaning courses. In our system, the authors are provided with means to divide the process in small pieces, to enhance their productivity by exposing their work to group review, and to take profit of colleagues' expertise, and also to discuss, exchange ideas, etc. Finally, working in a group, authors may improve the e-learning authoring process, enrich the course's content and reach a better final product.

In the proposed environment, we chose not to adopt a complex groupware system, but only to use a few cooperative functions, necessary for the success of the work. Thus, we chose to improve our tools with functions like awareness and annotations, while we remain closer to simple applications design, working with open and worldwide known protocols and technologies. These cooperative functions are presented below.

4.1 Awareness

As stated before, we believe that the work executed within a group produces better results through an harmonic interaction of the group members. To reach this harmonic interaction, the group members need to be aware of the colleagues' activities, because, according to Gutwin and Greenberg [5], being aware to the colleagues and their activities in the group is important to make the progress work natural and fluid.

This leads to the concept of awareness. Awareness is the knowledge on group activities, including past, presents and future activities. It's also the knowledge about the group itself and its overall status [8]. It is the awareness support that makes possible to transform irregular interactions in consistent interactions over time, allowing that the members be kept updated on the important events for the group [3], [2].

So, to help a group of users to create an e-learning course, we decided to give them some support to awareness. We enriched the tools used in the proposed environment with a small, but useful, awareness support. This has been done by the addition of the framework BW and a small awareness protocol, based on a XML structure. The framework BW was designed to provide awareness support, especially in asynchronous environments (like the Web itself) [9]. The awareness protocol allows the exchange of awareness information between client tools and an awareness server. Combining these elements with the others authoring tools, the users could receive the notification of many events, like changes or annotations made on a document, or even perform queries to filter them.

4.2 Annotations

Annotations act as a communication resource. They allow the co-authors of a document to exchange experiences, opinions, comments, questions, etc, and to enrich the cooperation process. Annotations give to the group the possibility to asynchronously discuss about the work they are performing together, leading them to a better document.

We have chosen, for this annotations resource, to use W3C's Annotea. Annotea is a web-based shared annotation system based on general-purpose open RDF infrastructure, where annotations are modeled as a class of metadata [7]. It treats annotations as external statements made by an author about a Web document. Annotea stores these annotations on central RDF bases, in one or more annotation servers.

As Amaya implements also an Annotea client, the users can easily use this resource without changing the application. They can add their annotations directly on the documents they are constructing. By using annotations, these users may exchange ideas, comments, questions, finally, they may discuss about the documents and cooperate.

Moreover, the annotations form an important communication channel, not only among teachers during the authoring process, assisted by the proposed environment, but also between teachers and students reading the courses. The use of Annotea covers both, and this can be very useful for the course presentation, which is not addressed in this paper.

4.3 WebDAV

In Section 2, we proposed using Amaya to create and publish web pages in a specifically configured HTTP server. However, just this combination Amaya/HTTP doesn't cover the "lost update problem" (when a user's update is overwritten by another user's update). To deal with this aspect, we introduce in the Amaya editor an Internet protocol designed for authoring purposes, the WebDAV. The WebDAV (WWW Distributed Authoring and Versoning) is a set of extensions to the HTTP protocol, which allows users to collaboratively edit and manage files on remote web servers [21]. It aims to extend the HTTP protocol to given place to an open architecture at protocol level, to develop new distributed authoring tools in the web, specially emphasizing the collaborative authoring of web pages [16], [20].

WebDAV defines operations over properties, collections, namespaces and overwriting protection, and for these operations, it defines new methods, headers, request and response entity bodies [4]. Nevertheless, versioning features, present in the original proposition, have been moved to Delta-V IETF work group, which aims to extend WebDAV and HTTP/1.1 for those features [22].

The "lost update problem" is a real issue in cooperative environment, because important user's contributions can be lost. To prevent this problem in our environment, we added in Amaya a WebDAV support, which is able to interact with Apache HTTP server that already deals with DAV requests.

Figure 4 presents the proposed environment for e-learning authoring after the aggregation of these cooperative features.

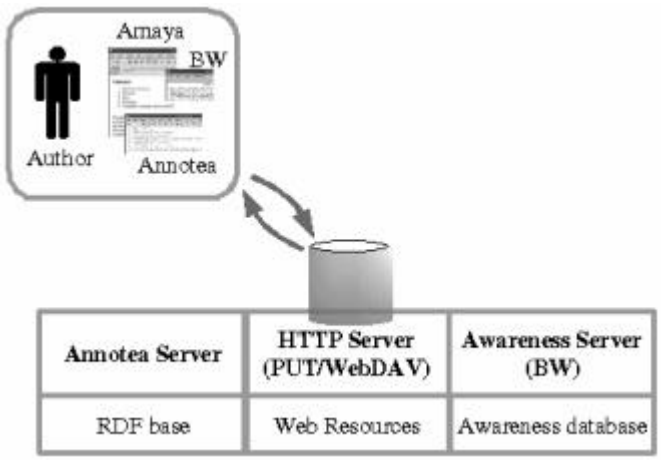

Fig. 4. Cooperative features

5 Workflow

To organize the e-learning authoring process and to connect all the features presented in the sections before, we introduced in the proposed environment a workflow element: the authoring workflow. This workflow defines the tasks for the creation of the course and their coordination within the authoring group. It allows controlling the authoring process, helping at the same time the professionals to create the course. It is not used to control the presentation of the course; neither does it define the students' tasks.

As stated before, the authoring workflow is defined by the coordinator of the group, taking in consideration (1) the members of the team, (2) the kind of e-learning course under construction, and (3) the standardization of the course development center. A basic authoring workflow was proposed in [17], and may be easily adapted for a specific course.

In our system, we purpose to introduce a workflow engine inside the server (the same server that includes HTTP and Annotea). This engine has an interface composed by CGIs and Servelets, that allows the environment tools, like web authoring tools, to interact with this engine and follows the authoring process. This authoring process is defined by a description of the workflow expressed in a predetermined language, an XML DTD specially defined for this purpose. Using this workflow definition language, the group coordinator may express the necessaries tasks, resources and constrains for the course creation. This coordinator may define what task should be accomplished and when. He can also associate a tool that allows accomplishing the task, or even define what should the task return after its completion (for example, by defining the URI where the resulting course resource should be published). By specifying this workflow, the coordinator defines the authoring process to be followed

by the group. In order to help this coordinator, a graphical workflow editor was constructed, using SVG support in Amaya. Through this editor, the coordinator is able to easily define the workflow. At the end of a workflow authoring session, the editor generates the XML description of the workflow.

This workflow description is submitted to the server, where the workflow engine is processed. By interpreting this workflow description in XML, the workflow engine determines what tasks, resources and constrains the workflow has to control. Besides this description, the workflow engine may use the awareness information to better control the authoring process. For example, the progress of a document could be seen through awareness events like document saves. These awareness information are maintained by the framework BW in a centralized database. This database can be periodically consulted by the workflow engine, which could then base some of its control decisions on these events.

On the other hand, the user will be able to interact with the workflow engine by its CGIs interfaces. Using these interfaces, the users may request a task, following the workflow sequence and constrains, and also interactively supply information about the realization of the task to the workflow engine (for example, by clicking on specific URLs when the task is completed).

Figure 5 shows the complete environment proposed in this paper: a server, where all the server processes are running (the workflow engine, the HTTP and Annotea servers) and data (created pages, multimedia resources and awareness data) are placed, and clients using multimedia tools and the Amaya editor, enriched with awareness support.

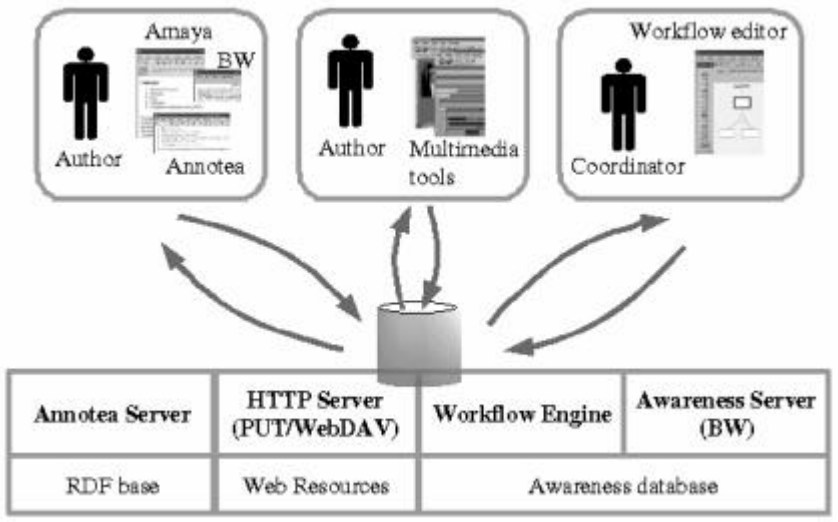

Fig. 5. The proposed environment.

6 Future Considerations: Presenting the Course

In this paper, we presented only the e-learning authoring process support in the proposed environment. However, the authoring process is not the only process involved in e-learning. Complementing the authoring process, there is the learning process itself, where the created course is presented for the students. We did not cover the execution process in the proposed environment but it is considered for future work.

Execution support for the workflow is in fact an important component. It controls the presentation course and the student's progression along the learning workflow. This execution workflow should define which tasks are mandatory and what tasks are optional. It defines also the order in which the student should accomplish those tasks, etc. It should control the course execution to guarantee that the course content (or its mandatory partly) will be correctly presented and followed by the student.

In an ideal situation, the workflow should take into account the student's profile and preferences such as the type of lecture (mandatory or a visitor) and level (a beginner, an intermediate or an advanced student) to take some decisions. Ideally, the course content should be adaptable to the student according to his characteristics. To reach this goal, we can introduce a negotiation service in the e-learning environment. The negotiation task aims to deliver a best content according to the client profile. The profile can be specified efficiently in a RDF [11] or a CC/PP structure [19]. The client can then negotiate with the content server using these structures in order to locate and receive adapted courses.

The client profiles may influence the workflow traversal. For example, if the course followed by the student is mandatory, the workflow will ensure that the course has been viewed once and submitted to evaluation sections. However, if it is a visitor, the student can freely navigate in the course content and has no evaluation sections. The profiles may also include a student's level description, the courses already followed, and other useful information that may help to adapt the workflow traversal and the course content. Based on those profiles, the negotiation task can be applied dynamically and added to the currently followed set of courses.

Since actual protocols, such as HTTP [14] and TCN [6], are based on pure versioning selection mechanisms and lack negotiation support, a perspective for these negotiation services is to use a negotiation layer on top of these protocols [12]. The use of a specific intermediate entity for negotiation purposes between the student and the execution workflow may also help in dealing with "off-line" situations where the student will be disconnected from the network and still wants to follow the course. It is also possible to negotiate with the workflow for an off-line condition where the courses have to be uploaded on the client before disconnection. It will be possible also to deal with synchronization of the tasks accomplished off-line and the workflow after the reestablishment of the connection. There is still a lot of work to achieve in this direction in order to obtain a negotiable content for e-learning.

7 Conclusions

In this paper, we proposed an e-learning environment mainly based on open tools and standards. This allows obtaining low cost systems applicable in almost any real world situation and deployable at a large scale. For example, in under-development countries, low budget institutions may take profit from this environment to produce their own e-learning material. Besides this, the proposed environment allows to take advantage of modern technologies brought through the latest web standards. We have shown how XML has been used in the Awareness Protocol, XHTML, MathML and SVG in the web pages created by Amaya, SMIL in the multimedia creation tools, and WebDAV under Amaya.

We presented in this paper the authoring part of the environment, which was designed to offer a support for authors producing cooperatively e-learning materials. It allows the authors to define and follow the authoring process under the control of the workflow. This workflow and all tools associated, like Amaya, do not perform any kind of semantic control over the course content. That is, the content of the course produced with this environment is created and controlled only by the authors themselves. Despite of this, we believe that the work in a group, composed by educators and technical people and the presence of a workflow describing the authoring process will help those authors to produce a better course content.

This environment is still under construction in two sites, one in France, at the Opera research group at INRIA Rhône-Alpes, and another in Brazil, at the Sigha research group at UFRGS. Some features are in a more advanced development stage, like the web authoring tools, and others are at their initial stage like WebDAV and workflow. This later is one of the most important pieces of this environment and constitutes an innovation. We expect, by implementing this component, to enhance the e-learning authoring process and relief the authors from constantly dealing with coordination tasks.

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