E-learning 2.0: you are We-LCoME!

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ABSTRACT

The Internet is turning into a participating community where consumers and producers of resources merge into "*prosumers*", dialectically sharing their knowledge, their interests and needs. This Web 2.0 archetype is now strongly impacting on e-learning methodologies and technologies, by enforcing the participation of students in creating and sharing materials and resources. Overcoming latent alarms introduced by the coming out of new complex tools, e-learning 2.0 represents a new challenge for accessibility. The production of accessible contents can now be turned from an impossible mission centrally managed by teachers and institutions to a joint work of people improving learning materials.

In this context, we present an e-learning 2.0 tool, designed and developed to support users in editing educational resources and compounding multimedia contents through a collaborative work. Starting from a multimedia resource provided by the lecturer, an entire community can contribute in adding alternative contents and views, creating a multidimensional information structure. The resulting enriched resource can be tailored to a specific user by resorting to automatic adaptation mechanisms. This system can be used to transform the content production workflow, involving all the different actors (lecturers, learning technologists, student support services, staff developers and students) playing a role in improving accessibility and, more generally, effectiveness of learning materials.

Categories and Subject Descriptors

H.5.1 [**Multimedia Information Systems**]: Evaluation/methodology;

H.5.1 [**Hypertext/Hypermedia**]: User issues;

K.3.1 [**Computer Uses in Education**]: Collaborative learning;

K.4.2 [**Social Issues**]: Assistive technologies for persons with disabilities.

General Terms

Human Factors.

Keywords

Accessibility, Web 2.0, E-learning 2.0, Multimedia Editing.

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1. INTRODUCTION

E-learning 2.0 has *lighted a new torch* over processes and roles in acquiring knowledge. An heterogeneous community of teachers and learners can dialectically share and improve their knowledge, lit up by Web 2.0 facilities and massive multimedia employment. This trend has a particularly strong impact on e-learning, finally offering new tools and methodologies to effectively work as in an on line community of practice, articulated and promoted by people [5]. Rather than being composed, organized and packaged in static learning objects, new evolving e-learning contents can be dynamically created, aggregated, classified, syndicated and shared by students.

The traditional way pursued by e-learning has been overcome by the wide use of Web 2.0 applications, from blog to podcast, from wiki to media sharing. From the accessibility point of view, e-learning 2.0 and its related novel Internet technologies represent a pitfall challenge [14]. On one hand, dangers for accessibility are embedded in every innovation and the complexity of collaborative 2.0 tools effectively represents a risk of exclusion for people with disabilities. On the other hand, the participation of people to the creation and management of contents is recognized as a great potential for e-learning accessibility.

Usually, accessibility of e-learning contents is made possible by the activity of the lecturer and learning technologists, working together to enrich, transform and standardize resources originally designed without taking in account their accessibility. New e-learning 2.0 methodologies and tools could be easily used to make accessible e-learning in practice, by supporting processes that engage all the different actors, from lecturers to students, including people with disabilities, join to work together.

Let us consider, just as an example, a video-lecture recorded by a teacher, to be used during an e-learning course. In the traditional approach, the video-lecture is recorded and, for each component stream (e.g., audio, video, slideshow), a set of textual alternatives have to be made available. Usually, the lecturer provides alternatives to images, while the student support service may provide captions to the lecture's audio track. Then, the product is closed and packetized into a standardized LO.

In the new e-learning 2.0 approach, the first two steps mentioned above can be complemented by collaboratively annotating the lecture, improving and adding alternatives. For instance, additional schemas can be used to enforce concepts explained by a textual description, adding new resources that could be useful for learners with learning disabilities. It is worth noting that the whole learning content's production process, from its creation to delivery, can be shared by the all the learning actors, instead of been a personal realm of teachers. Thus, learning content editing can be seen as a collaborative process for authoring multimedia resources, integrated as complements to an original didactical content.

In this scenario, this paper describes We-LCoME (Wiki e-Learning Compound Multimedia Environment), a novel e-learning system where Web 2.0 methods are utilized, together with adaptation mechanisms, in order to offer an absolutely open playground for authoring, modifying and publishing multimedia learning resources. Such a system exploits a new wiki-type language we defined, able to describe multimedia contents, their mutual relations, their synchronization and their available shapes (according to the device capabilities, user's preferences and their accessibility). Specifically, this wiki-like syntax allows to manage temporal and spatial relations among media contents composing the rich media and, contemporarily, results as quite easy to use. The language allows to addresses accessibility and device-dependence issues. This clearly facilitates a wide and inclusive distribution of the created contents. Our extended wiki platform is based on a suitable engine – on an hybrid client/server form – implemented to render (or interpret) the wiki-like code, and to present a final compound multimedia, shaped into different formats. The main target is the SMIL standard, but different presentation alternatives can be provided for such rich media, depending on the specific user needs.

The system is able to classify contents on the basis of their accessibility by using ACCMD, the well-known standard for ACCessibility MetaData [10]. Indeed, a metadata manager in our system is responsible to consistently store ACCMD metadata related to each resource composing the multimedia lecture. Such information is then exploited by the adaptation system, which manipulates media elements composing the multimedia lecture, based on the specific accessibility needs of the user (these are expressed by using the ACCLIP profiling standard [11]).

We claim that our system may really help to improve the accessibility of learning resources, thanks to the active collaboration of learners. In particular, it will be possible to improve e-learning quality and effectiveness, supporting students with difficulties in studying a particular subject, with learning disabilities, with physicals/sensorial disabilities, etc. This way, everyone who has been made able to participate become an author.

The reminder of this paper is organized as follows. In Section 2 we outline the main background related to multimedia authoring. Section 3 discusses on main design issues. Section 4 presents the system architecture and Section 5 shows a typical scenario of use of We-LCoME. Finally, Section 6 concludes the paper.

2. BACKGROUND

In this Section, we present some projects related to multimedia authoring. Most of them present interesting and useful features, but they are mainly designed to be used as standalone systems, instead of Web-based ones.

Nowadays, Internet is widely exploited to share and publish video, audio and multimedia contents. A main example is that of peer-to-peer based sharing applications, e.g., BitTorrent [2]. Not only, novel Web 2.0-based applications now allow to publish images and videos on personal blogs and virtual spaces. YouTube [27], GoogleVideo [9], mySpace [15], Facebook [6], are just some few representative exemplars. One of the main characteristics of these applications are concerned with the possibility, let to users, to freely define and associate tags to the uploaded contents. This really helps to search and discover new contents. Obviously, these interesting systems provide users with new opportunities for distributing contents to a wide community. Unfortunately, they do not offer cooperation features that, for instance, allow other users to change the published content to improve their accessibility (e.g., by adding captions). Furthermore, they do not allow any collaborative participation during the media authoring process.

In order to promote effective cooperation strategies to improve accessibility of multimedia contents deployed on the Web, suitable editing features are needed. Furthermore, contents must be encoded and stored according to formats which allow to enrich them with additional information, so as to produce accessible contents. In this sense, a viable candidate is represented by the SMIL technology, when exploited according to the WAI (Web Accessibility Initiatives) guidelines [23, 26].

The SMIL MediaAccessibility Module [26] defines the attributes which are related to media description and their accessibility. Such a module is composed by the following attributes: **`alt`** (which specifies alternate text, for user agents that cannot display a particular media object), **`longdesc`** (which specifies a link to a long description of a media object), **`readIndex`** (which specifies the position of the current element in order in which **`longdesc`**, title and alt text are read aloud by assistive devices for the current document). Despite of their notable usefulness, such attributes can't exhaustively cut off the barriers against accessibility. Loss of synchronization among media elements and features of widespread players thwart the efforts toward accessibility, this module has done.

Moreover, to ensure the formation of an inclusive community, the software exploited as the editor itself has to be accessible, in compliance to ATAG (Authoring Tools Accessibility Guidelines) [24]. As a matter of facts, no existing authoring applications support all these features. Rather, just some multimedia authoring tool partially addresses a subset of the above mentioned issues [1, 16].

As an example, a collaborative multimedia authoring system is presented in [22]. Such a tool provides a 3D spatio-temporal interface which represents the multimedia presentation in a seamless environment. The system is composed by several components, devoted to manage different features, such as editing, collaboration and media organization. The editor provides means to manipulate the timeline of the presentation, associate tags or attributes to contents, add text. All these editing features are shared over the Internet, so that users in different places can edit multimedia presentations in a unified spatial-temporal dimension. SMIL is used as the technology to synchronize media contents [26].

Some other existing SMIL authoring tools provide basic user interfaces to manage both the temporal and the spatial aspects of a presentation. These are typically exploit scaled timeline-based user interfaces (representing, for instance, media objects as different bars arranged in multiple layers), or textual interface to add and manipulate SMIL tags and attributes [12, 28].

Another authoring multimedia tool has been presented by Stergar et al. in [18]. The described environment is based on the use of a timeline exploited to specify temporal and spatial composition of different media. A multimodal user interface allows users to interact through non-standard input modalities, such as speech and gesture based ones. The paper discusses on different kinds of authoring, by describing their main features and describes examples of external applications developed by using the presented framework.

[21] describes an authoring tool to create and edit multimedia tutorials in e-learning environments. The system allows to manage different kinds of media, such as text, graphics, animation, sound and video. Mainly, such an application provides a way to control student interactivity within flow chart based multimedia presentations.

Multimedia presentations used in e-learning contexts are on the basis also of the project described in [13]. Its main goal is to create online courseware for teaching presentation skills to engineering students by pooling the learning resources available on the campus and showcasing examples of how engineers apply these lectures to real presentations. The presented authoring multimedia application is able to generate contents and to combine them with results coming from student testing.

The common problem of all these cited works is that these typically do not take into consideration accessibility issues, often both in terms of the user interface made available to prosumers, and of the final produced contents. Moreover, these are not Web-based systems and do not present any collaboration features.

In [8], authors present a framework which allows to develop content classification and management based on metadata, such as social relationship. The main aim of this work is to preserve accuracy, availability and personalization of contents provided to users. The framework enables the development of multimedia authoring systems focused on multimedia creation, distributed user collaboration and content retrieval. This is one of the first projects which tried to match social networking and multimedia authoring. However, the user collaboration aspect is mainly limited to multimedia tagging and rating. In fact, the authors developed the so called *Online Community Life*, a community based blogging portal for travel diaries, which allows a rich media authoring, sharing, rating and tagging of journey reports. Accessibility is not taken into account neither in the resulting multimedia content nor in the system interface.

Focusing on collaborative authoring and editing activities, actual Web 2.0 applications typically offer simple blog and wiki based online services. These systems promote effective and cooperative work strategies to manage contents, but they are often limited in dealing with multimedia resources. Indeed, both blogs and wikis support a simple inclusion of multimedia resources as closed containers.

3. DESIGN ISSUES

Mashing up compound multimedia with arising technologies and trends on the Web 2.0 realm is an outstanding instance, which goes beyond the state of the art. Whenever practices such as open editing, personal expression or wrapping one' own design around content are to deal with multimedia, they refer to "*those obscure objects of desire*" rather than really managing media resources.

Moving or tagging multimedia *black boxes* from one's own client to the World (Wide Web), as it currently happens on wikis, blogs or systems such as YouTube [27], MySpace [15], and Facebook [6], is far away from collaboratively managing and sharing contents of multimedia. Such an unexploited participation becomes a missed enhancement process whenever dealing with multimedia learning objects on an e-learning platform.

A community of learners, which is able to notice and enrich slides, subtitles, schemes, on a compound multimedia lecture can really improve quality end effectiveness of learning resources. Interfaces play a notable role in opening such boxes; they have to make processes of editing as simple and friendly as possible, according to the "*collective creativeness*" principle of Web 2.0 users. Along the authoring phase, contemporary and sequential media inside a compound multimedia have to be shown and arranged, so as to be recognized and managed.

On the presentation phase, each resource has to be dynamically rendered as an *unicum*, according to a consistent state. To this aim, it is worth noting that accessibility of resources, together with their adaptation to different devices and users' preferences can really take advantage from the typical iteration process provided by collaborative editing, once the users are bound to add meta information. Indeed, metadata information associated to media resources permit to select those resources which (after some possible preliminary manipulation/customization) can be easily presented to a given user, depending on its personal and technological characteristics.

Starting from a previous work [20], we designed and implemented a system which provides suitable workflows to bind users adding meta information about media contents and their accessibility. Each single media composing a resource can be created, modified, deleted from users, which become jointly responsible, together with the system, of any information about content features and its accessibility. In the rest of this Section, we describe the main characteristics of this system.

3.1 We-LCoME at work

The We-LCoME system has been developed to allow the cooperative creation and sharing of SMIL-based multimedia resources. Based on our system, users (typically learners and teachers) are able to enrich the didactical material made available to the learning community. Specifically, they can add captions/subtitles and annotations (shaped as images, videos or audio clips, text) to the original multimedia contents by resorting to a wiki-like interface. This open process promotes students' participation, data decentralization, assemblage from diverse sources, sharing of knowledge as well as an improvement to the efficacy of e-learning materials [20].

The use of SMIL, as a key technology to structure our multimedia presentations, is motivated by the fact that this language allows to describe the spatial and temporal relations inside compound multimedia. However, manually coding such a markup language can be a very complex and awkward activity, closer to any insider's skill specific skills, rather than to the actual trends of user friendly content management system, and very far from common prosumers' abilities.

Our system surmounts this potential problem. Indeed, We-LCoME transforms SMIL documents into a simpler representation, where elements of a compound flow of media can be punctually recognized and noticed by users. A suitable engine rebuilds the SMIL document so as to show the results of the noticing process.

Concurrently, aiming at building a system where multimedia contents are collaboratively edited by a multitude of users, our approach follows philosophy of wiki engines (i.e., "the wiki way"), which represent a de facto key technology for enabling user collaboration on the Web [3, 17, 20]. The syntax available in wiki systems, the so-called wikitext, typically exploits plain text with a few simple conventions so as to mark up edited contents [7], which are automatically converted into a final HTML document [3]. Nor a standard for syntax, neither a common grammar are shared by the wiki flavours on the net. They pursue different ways to the same speed and simplicity target (as the taxi in honolulu which inspired the Wiki philosophy). Hence, wikis have different constructs to be applied for links, images, lists and so on. In any case, a Web-based editor allows users modifying the wikitext source of a page, by means of a visual approach (typically a WYSIWYG interface) or directly typing the suitable syntax. We-LCoME exploits the features of Dokuwiki [4] and extends its syntax to allow additional annotations, captions and subtitles on the items composing a SMIL rich media. The strength of the "wiki way" is meant as its easiness, openness and speed of use, as soon as its short learning curve.

We-LCoME allows to add captions and subtitles, meant as textual alternatives to figures and audio streams, respectively. Not only, also annotations can be added which summarize, comment, schematize upon the contents of a given audio/video/image element. To this aim, We-LCoME provides the user with the list of audio/video/image elements composing the lecture. On the basis of this list, annotations can be added using a wikitext syntax. Such annotations are then translated and stored as an HTML document to be associated as an alternative for that specific audio/video/image element. Obviously, once created, a link is established between the produced HTML document and the main SMIL document, which is comprised of all the pointers to the audio/video/image resources for which We-LCoME has created alternative descriptions [20].

Figure 1 shows the process of collaborative editing inside We-LCoME. The video lecture, provided by p1 on phase 1, is stored into the system as a Learning Object (LO). Users labeled as p2 and p3, collaboratively add captions and resources through the We-LCoME editing interface, which shows the wikitext representation of the SMIL document extended with the e-Learning Wiki System (e-LWiS), which will be detailed in the following. Once such a source code for the lecture has been noticed or enriched, the editing system rebuilds the SMIL document and updates the LO repository with the modified contents.

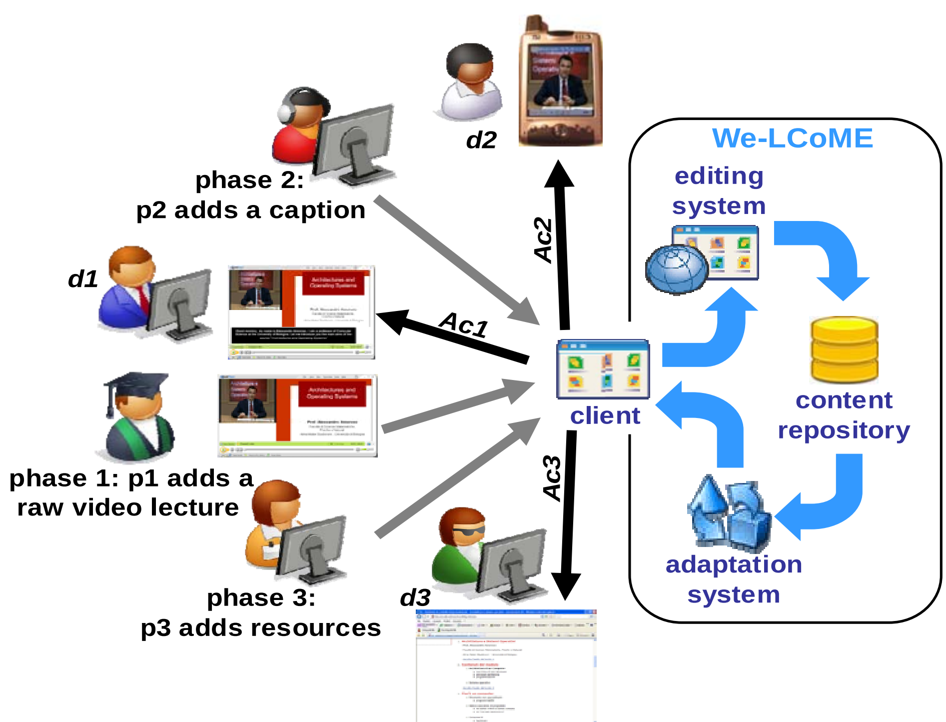

Figure 1. We-LCoME Actors and Functionalities.

Accessibility metadata, which are enclosed on the media composing the lecture are updated too. To furthermore simplify the access to the rich media which are iteratively produced, We-LCoME has been integrated with ad adaptation system. On the "anyone, anywhere, with any device" Web 2.0 realm, content must meet users' preferences and devices capabilities. This assumption has driven We-LCoME to provide a subsystem generating different shapes of media, according to the context of presentation. The discussion on the mechanisms, which this component is based on, is just briefly introduced on the next Section, but it is out of the scope of this paper. Interested readers can find a detailed discussion of these issues in [7, 19]. The fulfilled task of the adaptation system is shown in Figure 1, where users labeled d1, d2 and d3 access the rich media content shaped to meet their necessities (both physical and technological).

3.2 Sharpening the Occam's razor

We-LCoME has been designed to simplify the process of editing rich media. It allows a class of prosumers to improve quality and effectiveness of a video lecture, to dialectically share the didactic material they are provided. The "wiki way", which has been pursued, or, simply "all other things being equal, the simplest solution is the best", as the Occam's razor principle states. The awkward managing of SMIL documents has been turned into the wikitext syntactic sugar, and all the typical features of a wiki, such as speed and openness to a collaborative work, have been extended to the media components of a compound multimedia object. As it concerns to the users point of view, the adaptation system eliminates further complications about content access. Notwithstanding these results, collaboratively editing of media provides new entities to be taken into account so as to obtain a really *lex parsimoniae*: the accessibility of noticed contents.

While we may expect the original video lecture to be accessible, i.e., to present textual alternatives, captions, and any other solution to build up suitable "*curb cuts*", any act extending or noticing media elements provided by a community of learners can spoil the availability of the lecture. On the other hand, whenever the initial expectations about any media element are betrayed, users might improve (and often, simply, make) its accessibility by adding captions or subtitles to the media composing the video lecture. In any case, the adaptation subsystem may depend upon the alternatives provided for each media (added, enriched with a note or extended with a caption) to be in charge of properly shaping contents. While adapting contents to the devices capabilities is absolutely an automatic process, meeting users' necessities, needs proper resources.

Let us detail which are the activities any community (made of the lecturer, the students support services and the learners) can do:

- On the very first phase, the teacher submits his/her lecture to We-LCoME, to be delivered as a didactical material. In terms of accessibility (based on guidelines and laws), he/she's forced to ensure that: every media content has an alternative, if needed. For instance, images have to be accomplished with textual alternatives, audio speeches are to be added by captions, and so on.
- Once the lecture has been delivered, learners and the teacher him/herself are provided with a suitable interface to note, add, modify each media which the lecture is grained in. By adding subtitles, schematizing textual or verbal explanation, noting any media to clarify concepts, improve the accessibility of the didactical material. This kind of enrichment supports a wider range of learners.
- Finally, the lecturer has the responsibility to validate any change the community has done. The added notes may be subject to remarks and further refinements of the lecture.

Accessibility of the lecture is obviously improved by this kind of contributions. However, meta information about relationships among existent and added media elements must be present to be exploited. Needless to say, the amount of metadata present in a rich media contents grows up together with additional contents that users may add, during the collaborative editing activity [20].

Accessibility of learning objects stored inside We-LCoME is described through the ACCMD standard, which is also used by the adaptation system to retrieve information about available shapes of content. The following chunk of code (Figure 2) shows an example of ACCMD document describing an animation (both video and textual) and its alternative (a static image).

```
<accessibility
xmlns="http://www.imsglobal.org/xsd/accmd">
<!— an animation and its equivalent image -->
  <resourceDescription>
    <primary hasAuditory="false"
     hasTactile="false" hasText="true"
     hasVisual="true">
      <equivalentResource>
        file://img/image024.jpg
      </equivalentResource>
    </primary>
  </resourceDescription>
</accessibility>
```

Figure 2. Example of ACCMD code.

As shown in the Figure, the `<accessibility>` tag is the root element, enclosing the accessibility information about the resource. The `<resourceDescription>` tag details the features of the resource. The `<primary>` tag defines the features of the primary resource. Its attributes respectively indicate:

- `hasAuditory`: Boolean value that indicates whether or not the resource contains auditory information;
- `hasVisual`: Boolean value that indicates whether or not the resource contains visual information;
- `hasText`: Boolean value that indicates whether or not the resource contains text;
- `hasTactile`: Boolean value that indicates whether or not the resource contains tactile information.

The `<equivalentResource>` element is a pointer to an equivalent resource (metadata) of the described resource or parts of it.

As it happens with SMIL, ACCMD is an awkward object to manage and, on We-LCoME, such a further overhead of information has to be put under the responsibility of users. It means that a novel complication is added. Hence, in order to sharpen the Occam's razor, we added an interface to update the ACCMD metadata along the authoring process.

Analogously to what has been done with SMIL format, ACCMD has been turned into an available format, as simple as possible. Features of resources candidate to be added are inherently characterized in terms of accessibility. Typically, a caption "hasText", as well as a subtitle, and it is an "equivalenResource" to an audio track; an image "hasVisual", and so on.

In substance, thanks to this new feature, the workflow of media editing has acquired a new trigger, which allows users to describe relationship among media resources. The ACCMD heaviness can be lightened by exploiting the information cited above. Therefore, each time a new visual, textual or audio media is added as a note, a caption, a subtitle or, in general, as a new resource, users should declare their relationship (primary or alternative) with other resources. Moreover, the system states their shape (visual, textual, audio) and updates the ACCMD specification, or build it and, finally encapsulates meta information on learning objects descriptors.

4. SYSTEM ARCHITECTURE

Our system is structured as a distributed software architecture, as shown in Figure 3. It is composed of a Web based front-end, accessible through a browser. Users are enabled to:

1) upload their files through a HTTP service;
2) collaboratively edit the available contents through the wiki-like interface and e-LWiS;
3) enjoy contents through a Web-based broking service that follows and guides the user during the content retrieving process, so as to provide him/her with a suitably adapted presentation.

Wiki-based editing facilities for the collaborative production of complex SMIL-based video lectures have been developed on top of DokuWiki, i.e., a well-known open Web platform for the collaborative editing of documents [4]. In particular, DokuWiki modules have been utilized to build the editing interface and a suitable extension in order to simplify the management of metadata about accessibility. Moreover, DokuWiki tools have been exploited to provide users with the possibility of adding new resources and enriching already existing media composing the multimedia learning contents, as alternatives during the presentation of the didactical material.

As to SMIL-based resources, a content analyzer is embodied in our system; this module is devoted to parse original SMIL documents, once they have been uploaded by users. In substance, the SMIL code is analyzed and all single media resources composing the multimedia presentation are identified and registered. The content analyzer is also devoted to control newly edited contents, so as to track any changes made by collaborative users on learning objects. New edited/uploaded contents, together with their timing synchronization specifications, encoded, based on our wikitext syntax, are maintained in a content repository.

In our architecture, a specific software component has been developed which manages the ACCMD specification. This specification is modified each time a newer version of a learning object is produced, as detailed in the previous Section. All ACCMD metadata are stored in the content repository together with the learning contents.

We already discussed that the more the media resources composing a given learning object are, the richer the ACCMD specification becomes, the more the available alternatives for content presentation has to be and the more accessible the content itself could be. To allow different presentation modalities to different users, depending on their personal characteristics and on the exploited device, our system architecture includes software modules devoted to dynamically adapt learning objects. Contents adaptation is performed either through selection of suitable media elements, either by triggering adaptation procedures for the involved resources.

In essence, based on the user profile and on the presentation alternatives composing the requested multimedia content, the adaptation system dynamically selects those kinds of media elements that can be presented to that specific user. For instance, text (easily readable by a screen reader) and audio flows are employed for blind people, while visual media are utilized for deaf ones, and only lightweight media are exploited for users with resource-constrained (e.g., handheld) devices.

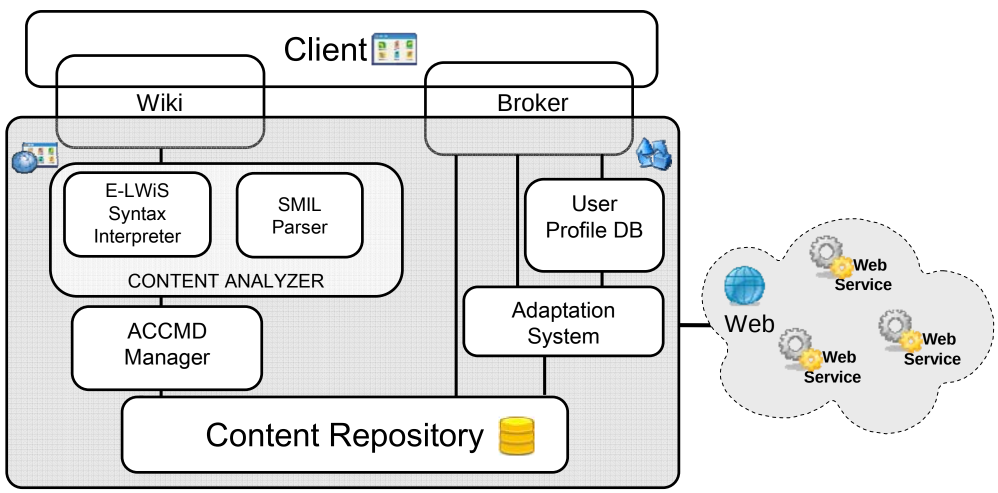

Figure 3. System Architecture.

Moreover, transcoding policies are employed on specific media contents, so as to make them enjoyable by users. For instance, audio (video) flows can be converted into formats which can be played out by a specific client device. Complex SMIL-based presentations, with multiple media flows combined to be played out in parallel, can be converted into sequential (XHTML-based) presentations. This could be really useful when, for example, students with disabilities (e.g., blind users) access the lecture. Indeed, this approach avoids any forms of cognitive overloads [19]. To make this possible, following the Web 2.0 philosophy our adaptation component exploits transcoding facilities offered by Web services, orchestrated as a mash-up of services depending on the scheduled adaptation procedure.

To obtain a properly adapted learning object, the user is asked to interact with a Web-based interface, through which a broker module is activated. During such interaction, the user passes to the broker his/her user profile. The profile is made of an ACCLIP specification together with a CC/PP specification [25]. This allows taking into account both the personal preferences of the user and also the technical characteristics of the exploited client device. Once a user profile has been detailed during the first access to the system, it is typically stored in a database, so as to fasten future interactions with the customization service.

Each time a request is made by the client, the broker passes the user profile to the adaptation system, which in turn triggers and orchestrates a transcoding process, specifically designed for that user profile. A detailed description of the adaptation module can be found in [19].

It is worth noting that the collaborative editing phase is completely independent to the adaptation phase, i.e., these are two asynchronous activities. However, it is evident that having more media alternatives available in the repository, which may have been cooperatively edited by users, augments the list of customization strategies during the adaptation process.

As to the communication protocols exploited in our architecture, our system is mainly based on HTTP, due to the Web oriented nature of the system. Furthermore, since several Web services are orchestrated and exploited during the adaptation process, when needed our system exploits typical protocols of Web services technologies, such as SOAP and WSDL.

5. USE CASE

In this Section we show how a typical workflow to edit and note media elements of a multimedia lecture works in We-LCoME. In particular, we focus on steps involved to ensure the maintenance of accessibility of the learning content, upon insertion or modification of some media resource, and also on the content adaptation. As described above, We-LCoME has been implemented as a wiki Web CMS (starting from Dokuwiki). Each generated page can be modified through a suitable interface, by exploiting the wikitext syntax, which has been extended to manage SMIL documents.

The reported example comes from a real use case of multimedia lecture produced for a course about *Architectures and Operating Systems*. The delivery to a community of prosumers has been limited to few testers (15 learners). Such a policy has been set up through the administration interface which is integrated on default DokuWiki distribution.

Figure 4 summarizes all the steps involved during the collaborative editing of the learning contents, based on the use of the We-LCoME system.

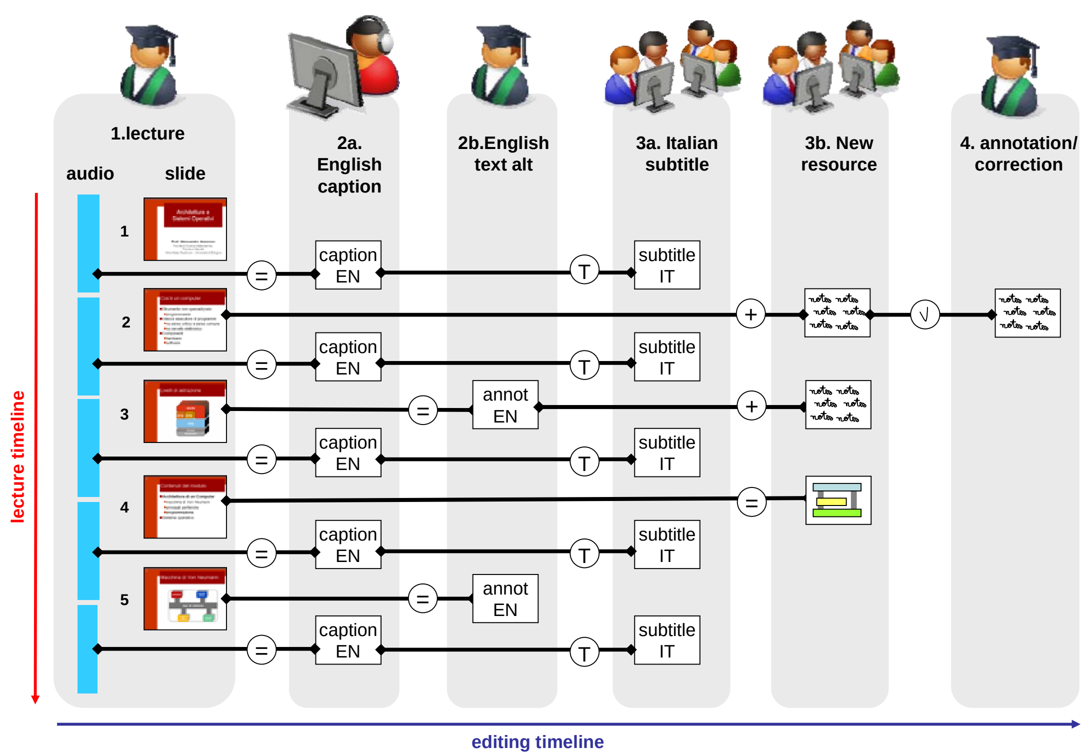

Figure 4. Dynamics of collaborative editing on a multimedia lecture.

Along the editing timeline, users add notes and media to a video lecture. The flow of the editing process is as follows:

1) The lecturer adds a video lecture (step 1 in Figure 4). We-LCoME allows to upload the SMIL document and provide its wikitext code on the edit interface.
2) According to accessibility guidelines and laws, mandatory elements are provided by the students support service staff and the teacher:
    a. Captions in English are added to the audio tracks describing a group of slides (step 2a);
    b. the lecturer edits alternative texts for images on slide 3 and 5 (step 2b);

    a and b activities can be made by using the wikitext extended syntax on We-LCoME edit interface, or before the SMIL lecture has been uploaded into the system.
3) Learners enjoy the lecture and spontaneously enrich it:
    a. Italian subtitles are added to translate the English captions in the (step 3a);
    b. Notes are added to slide 2 and to the alternative text of slide 3. An image which notes a textual explanation is associated to schematize some concepts of the slide 4 and declared as a visual alternative to this slide (step 3b).

    Likewise to the students support service staff, learners are allowed to access and edit each SMIL-lecture media through the edit interface of We-LCoME, by coding each note or caption with the extended syntax.
4) The lecturer corrects and confirms the notes of the previous item of the list (step 4). Such activities are currently made possible through an e-mail service provided by Dokuwiki. Each change to the page containing the SMIL-lecture is reported to the lecturer via e-mail. The standard versioning system of Dokuwiki allows for a roll-back, in case of unapproved changes. By exploiting the e-mail service which reports to the lecturer each note/change, learners (whose account is sent with the mail) might be rewarded for their efforts. Finally, We-LCoME renders the (possibly) modified lecture as a new SMIL-compliant object inside the Wiki XHTML page.

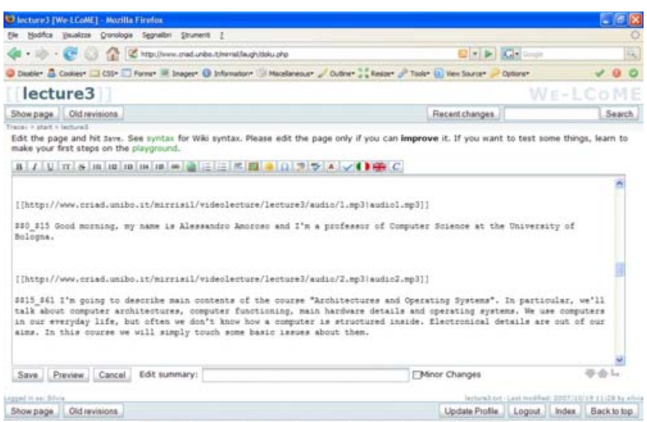

Figure 5. The wikitext interface.

The whole process listed above implies either mandatory actions (as for accessibility elements of the raw video lecture) and voluntary ones. The latter ones get the notable side effect to share in the accessibility of the final lecture. In the following, we detail how users may interact with We-LCoME, thanks to our Web-based user interface.

The wiki editing interface, with the audio elements and their related captions, is shown on Figure 5.

Captions in English language are added by using the wikitext syntax we defined, by means of the wiki editor (see Figure 6). Details about such a syntax can be found in [20] (summarizing, the `$$15_$61` syntax specifies that the caption is related to the audio speech, starting from the 15th second of the speech up to second 61).

```
[[http://www.criad.unibo.it/mirrisil/video
lecture/lecture3/audio/2.mp3|audio2.mp3]]

$$15_$61 I'm going to describe main
contents of the course "Architectures and
Operating Systems". In particular, we'll
talk about computer architectures,
computer functioning, main hardware
details and operating systems.
```

Figure 6. A wiki syntax fragment for captioning.

To accomplish such a contribution, users are finally bound to describe whether their work is a primary or an alternative resource, referring to the audio tracks they are captioning. Let us noting that captioning inherently corresponds to a “`hasText`” ACCMD attribute. Hence, the ACCMD manager automatically tracks the insertion of these new captions, by adding and associating such metadata to the content.

In the interface, suitable buttons, pointed out on Figure 7, have been added to the traditional wiki toolbar to allow the casting of new resources.

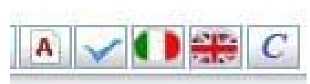

Figure 7. Suitable buttons added in the toolbar.

The first button on the left opens a pop up where the user is asked to describe the role (primary or alternative) on his/her note. According to the steps 2a and 4a of the considered use case, the user would reasonably assert that the caption is a secondary textual resource related to the audio speech (see Figure 8).

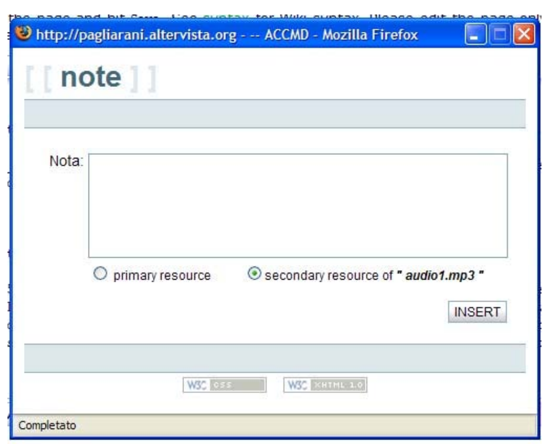

Figure 8. The ACCMD interface.

Also captions get their ACCMD code, in which they are defined as a secondary resource and "`hasText`". It is worth noting that audio1 too is to be described as a primary or alternative resource (of the corresponding slide).

```
<accessibility>
<resourceDescription>
<primary hasAuditory="true"
hasTactile="false" hasText="false"
hasVisual="false"/>
</resourceDescription>
</accessibility>
```

Figure 9. The ACCMD code for audio 1 resource.

The ACCMD chunk of code about audio1 is automatically updated; changes in the ACCMD specification for this media can be appreciated by looking at Figure 9 (which reports the ACCMD specification before the insertion of captions) and Figure 10 (ACCMD after the insertion).

```
<accessibility>
<resourceDescription>
<primary hasAuditory="true"
hasTactile="false" hasText="false"
hasVisual="false"/>
<equivalentResource>
http://www.criad.unibo.it/
We-LCoME/file1.txt
</equivalentResource>
</resourceDescription>
</accessibility>
```

Figure 10. The ACCMD code for audio 1 resource after the captioning.

Analogously, steps 2a, 2b, 3a feed the corresponding ACCMD metadata, which have been written out by the user. Let us consider that the referred resource of captions and subtitles are automatically assigned by the system. In fact, the syntactical sugar of the wikitext interface provides for the caption position to assign its referred resource. Once the user has put his/her text under the audio resource, it is meant to be associated to that audio.

Step 3b is slightly different from the previous ones. In this case, in fact, the user should declare his/her inserted image as a secondary resource for the textual slide it is related to. This is a clear demonstration of the claim stating that "*no assumption might be done about the role of a given kind of media*". The common case of a textual alternative to a visual image can be flipped as in this case.

Finally, on step 4 the lecturer validates the insertion of contents in the previous step, with the check button on the toolbar reported in Figure 7.

Based on the (meta) information retrieved from the updated ACCMD, the adaptation subsystem is able to shape contents to meet user's necessities. Deaf users can access the captions or their translation, blind users can listen to the alternative description of the inserted images and so on. As we stated on the introduction, there are notable advantages for learning disabilities too. The image schematizing texts on step 4 can really benefit to those ones with difficulties in understanding written information.

6. CONCLUSIONS AND FUTURE WORKS

We-LCoME aim is to mashup compound multimedia potentials with the so called "*collective intelligence*" which the new Web 2.0 has revealed.

Final e-learning media contents, once they can be really and simply shared by an open community of learning prosumers, represent a sort of added value, coming from the iterated process of noting and enriching contents. Such a process increases the quality, effectiveness and accessibility of learning contents. As Web 2.0 philosophy states, such a process has to be kept as simple as possible. We-LCoME has followed the Occam's razor principle to provide a friendly interface (based on the wiki way) to access each media of SMIL based video lectures. Furthermore, a suitable interface is provided to manage the ACCMD metadata about the accessibility of added contents.

Future works will improve the authoring interface so as to allow the control of the spatial dimension of SMIL based video lectures. The adaptation system, which is integrated to the We-LCoME platform, will be re-built in order to hit the mark of Web 2.0 collaborative footsteps, by sharing transcoding loads.

From an assessment point of view, our use case is to be extended to a wider group of users and to a longer period. The evolution of didactical material in terms of accessibility and availability will be exhaustively evaluated after that.

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