XML-BASED COURSE MATERIAL TRANSFORMATIONS FOR UBIQUITOUS eLEARNING APPLICATIONS

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Abstract: This paper describes our work in progress on ubiquitous eLearning. Today's learners are increasingly likely to engage in learning activities "on the fly" (while commuting, between other activities, on work breaks, etc.) than to use long, concentrated work sessions to learn course material. In order to meet the needs of these learners, a ubiquitous approach to web-based eLearning is required. This approach supports not just the traditional eLearning of a learner using a fixed PC to study, but extends this to learners studying in open labs/libraries/friends' PCs as well as on non-traditional devices such as handheld PCs, PDAs, iPods, cell phones and the like. An adaptive approach is required to deliver courseware in such a situation. The eLearning system must adapt to the learner's particular likes/dislikes, study session length, and learning style as well as to the characteristics of the learning device – screen size, bandwidth, networked or not, etc. We propose an XML-based approach in which metadata describing the learner's situation are continuously collected and refined and may be transformed via XSLT to meet the learner's needs at any particular moment.

1 INTRODUCTION

Several trends are emerging today which point towards the growing importance of ubiquitous learning – learning which takes place at any time and at any place. Among these trends are growing population of non-traditional learners. Many of these learners have full or part time jobs which require them to fit the learning into a crowded schedule. Learning must take place wherever and whenever possible and it is not possible to fit this learning into a fixed, rigid schedule. Older non-traditional learners often have family obligations which render them non-mobile as well – the learning must come to them rather than the other way around. Younger, more traditional learners also bring new demands to the learning environment. This generation is used to being entertained when and where they want, and may find traditional learning methods to be too constraining. In order to meet the needs of this generation, a more flexible, adaptive approach to learning – learning on the go is required. This paper describes our work in progress that is geared towards meeting the needs of today's generation of learners.

The basic framework needed to meet these needs is clear – web-based eLearning will be the preferred method due to the ubiquitous nature of the web and its underlying facilities and protocols. Standards-compliant web browsers are available on all manners of platforms, from servers down to cell phones and PDAs and are generally available on PCs in open labs and libraries. On the back end, metadata may be used to describe both the learning materials as well as to give learner profiles needed for customization (Arndt, 2001), (Arndt, 2007). The use of metadata allows for open, standards-based learning environments to be implemented, as demonstrated by SCORM (Advanced Distributed Learning, 2004). In considering ubiquitous eLearning solutions,

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adaptation to the different network bandwidths available to different classes of users must be taken into account (Salzmann, 2009), (Muntean, 2008).

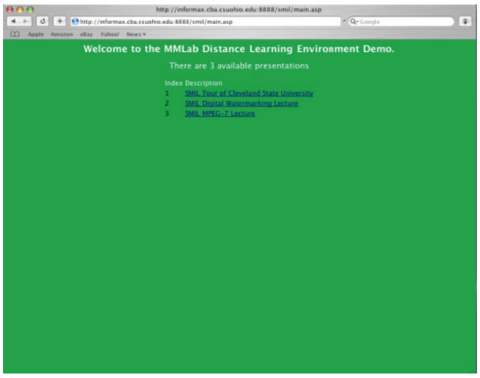

Figure 1: The Presentation Choice Screen.

In the following two sections we describe experimental prototypes we have developed which illustrate different aspects of adaptability for ubiquitous eLearning. Section 2 shows how we have used XSLT stylesheets to transform learning materials from one XML-based format to another for a customized learning experience. Section 3 describes a prototype system we have developed which selects an appropriate media stream for the learner based on a profile of his learning platform. In section 4 we discuss how we will integrate these two prototypes and extend them to capture further information about the user which can be used to customize his learning experience by the transformation techniques described in section 2.

2 TRANSFORMATIONS FOR ADAPTABILITY

We have implemented a prototype system which illustrates our approach to transformation for adaptability. The system consists of a number of documents which describe learning scenarios. The scenarios are described in an XML-based language called TAOML (Arndt, 2000). XSLT (W3C, 2007) stylesheets for several computing platforms have been developed. These stylesheets describe how to transform a TAOML-based learning scenario into a SMIL 2.0-based one which is specialized for the particular computing platform. This conversion is done using Microsoft's MSXSL XSL processor. An XSLT database holds the style sheets for the different platforms or different machine types. This database has various style sheets stored according to device type on which it will be displayed. They define a FDL (form definition language). The Server for the Distance Learning Environment is implemented using Active Server Pages. Users are authenticated against a database of users by comparing usernames and passwords.

After the user has been authenticated, he is redirected to the main page where he may choose the presentation he wishes to view. The list of presentations is generated dynamically from the database of presentations. The presentation and user databases in the prototype are implemented in Microsoft Access, however any ADO data source may be used. The presentation choice web page is shown in figure 1. New presentations can be added to the database at any time.

When the user has chosen the desired presentation, the ASP code retrieves the information on components of the SMIL presentation from the database and constructs the SMIL presentation. The IIS Web server then returns this file and the client browser's action depends on how the browser is configured to handle the MIME SMIL type. In figure 2, the web browser is configured to have the external RealOne player handle SMIL files. The player is responsible for integrating media for the presentation. In the prototype, all of the media files are handled by the file system of the server system. The architecture for the protoype is shown in figure 3 below.

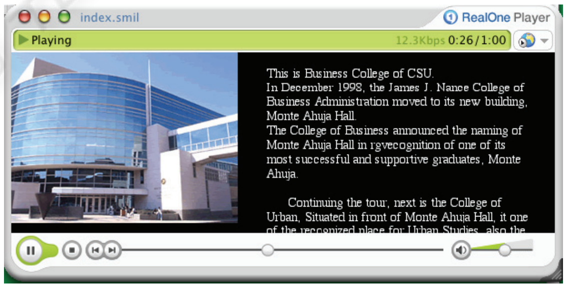

Figure 2: The SMIL 2.0 Presentation Generated.

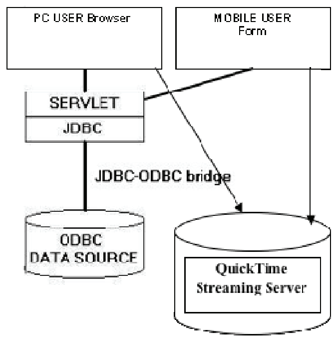

Figure 3: The Prototype Architecture.

3 PLATFORM SPECIFIC MEDIA STREAMING

In this experiment we have implemented a system that allows users to connect to a series of recorded lectures from a variety of different computing platforms. The system checks the capabilities of the system from which the connection is made and selects an appropriate multimedia stream (based, for example, on the viewing display) for the user's platform. In the rest of this section, we describe the implementation of the prototype system, and show examples of the system in action. In particular, we show the actions of the prototype for two classes of users, those on a PC and those on a cell phone (mobile users). The overall architecture of the system is shown in figure 4 below.

A Java servlet (LectureServlet) provides authentication to both PC users and Mobile users. Based on the http header it is determined whether the client is a PC or mobile user and the resulting authentication is sent accordingly (ACTION: AUTHENTICATE). The servlet also serves as the source for authenticated clients to fetch URLs of the lectures (ACTION: GETURL) the users wish to play with complete transparency to the user. The URLs, as well as authentication data, are stored in the database server accessed using JDBC.

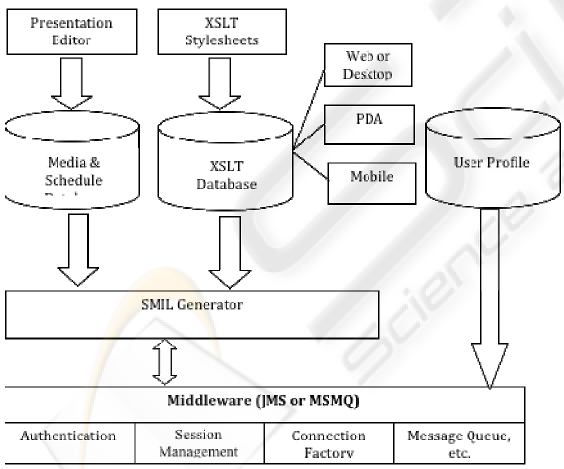

Figure 4: Three-Tier Architecture for the Prototype Adaptive eLearning System.

If a PC user contacts the LectureServlet it authenticates the user and generates an HTML form to take as input the particular Lecture Number and Lecture Part Number requested. These are used to connect to a backend database server using JDBC and the URL for the Lecture (streaming from QuickTime Streaming Server on a remote location) is fetched. The servlet then embeds a QuickTime player in the generated HTML page using dual way EMBED and ActiveX controls so as to enable users on different platforms to view the QuickTime video. The QuickTime player is embedded in the HTML with a complete controller interface so a user can PAUSE, STOP, PLAY, and ADJUST VOLUME at any time during playback. The user can go back and request another lecture as well. The use of the RTSP protocol ensures that the user does not know the URL of the playing lecture. A screenshot showing the PC-based system is given in figure 5 below.

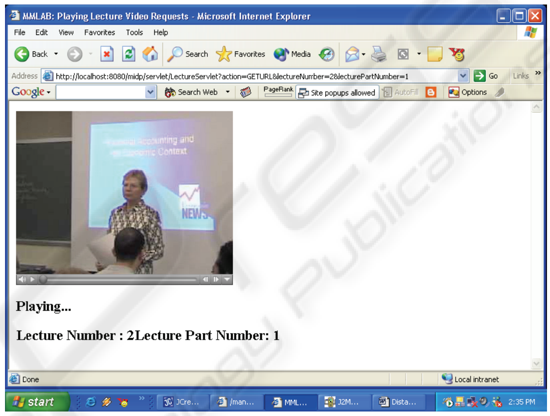

Figure 5: PC-Based eLearning.

The LectureServlet also enables mobile and PDA users to connect to it using the J2ME platform via MIDlets. MIDlets prompts the users for a username and password and contact the LectureServlet for authentication that is done for the LectureServlet by the backend database server using JDBC. Upon successful authentication, the MIDlet lets the user enter the Lecture Number and Lecture Part, which are sent to the LectureServlet to fetch the appropriate URL. LectureServlet replies with the URL or a message that the specific Lecture does not exist or is not available. The MIDlet, independent of the LectureServlet, contacts the specific remote Server for the video file and plays it for the user. This portion of the prototype has been developed using the J2ME Wireless Toolkit 2.1 from Sun Microsystems, the CLDC 1.1: Connected Limited Device Configuration version 1.1, and the Motorola Mobile Simulator. An example of the use of the prototype is shown in figure 6 below.

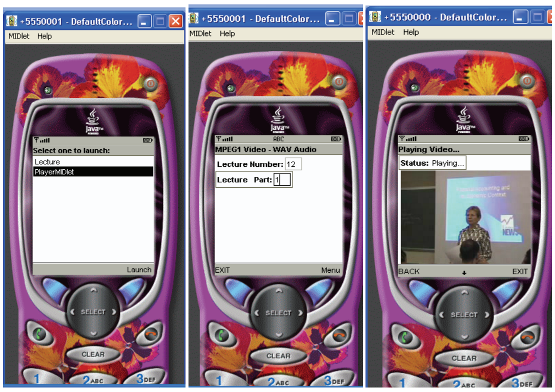

Figure 6: Cell Phone-Based eLearning.

4 CUSTOMIZED ELEARNING – DISCUSSION AND FUTURE RESEARCH

The previous two sections represent our basic approach to customized eLearning. User profiles containing information about learners (e.g. display device, learning preferences, level of proficiency, etc.) are stored in a database as an XML document. Information about learning materials is also as a set of XML documents. This information about the learning materials is actually metadata, or semantic information about the materials (Al-Khalifa, 2006). A set of data transformers (XSLT stylesheets) use the user profiles and metadata to transform the learning materials into a customized presentation in an XML-based language such as SMIL 2.0. The metadata which we have incorporated into our prototype systems is limited, however we are working to incorporate more advanced metadata, as represented by IEEE-LOM (IEEE, 2002). A general learning model (Gaeta, 2009) will be incorporated to allow for modification of user profiles

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