

Content Management Systems for Mobile Tele-Education

Ralf Tosse¹, Marcel Transier², and Jochen Seitz³

Division for Communication Networks,
Technische Universität Ilmenau,
D-98684 Ilmenau
E-Mail ¹ralf.tosse@tu-ilmenau.de
²Bickerdyke@gmx.net
³jochen.seitz@tu-ilmenau.de

Abstract. According to recent publications, tele-education is a vastly growing business that helps to satisfy the need for lifelong learning. Due to time shortage, it seems inevitable that tele-education will be more and more demanded by mobile users. Thus, any platform that provides tele-teaching documents, must also cope with mobile users. The question now is, whether already existing systems can be used and easily amended to fulfill this requirement. Therefore, the paper investigates the use of content management systems for tele-education platforms and identifies the functionality to be added for mobile users.

1 Tele-Education and Mobility

Mobile communication is the basis for one of the fastest growing business areas at the beginning of the 21st century. With IMT-2000 (*International Mobile Telecommunications 2000*), high-speed communication is possible anywhere, at any time, to any communication partner, with almost any device. As IMT-2000 comprises a set of different networking technologies, it provides a communication framework in which a subscriber may freely roam without having to be concerned about which network to use [1]. Hand-over procedures seamlessly integrate in-house networks, campus-based networks, metropolitan and wide area networks.

However, the companies active in the area of mobile computing made huge investments to secure a place for themselves in the IMT-2000 business. These investments must lead to an appropriate revenue achieved by mass acceptance of mobile data services. The outlook is quite optimistic, as the number of worldwide mobile cellular subscribers rose from about 23 millions in 1992 to almost 700 millions in 2000. But mass acceptance must on the one hand be achieved by networking architectures offering adequate quality of service and attractive tariffs. On the other hand, services have to be provided that make potential customers subscribe to a mobile network provider. And as a killer application for IMT-2000 has not been found yet, experts believe that business will be driven by a mixture of applications [2].

So the next question is which applications will belong to this mixture. The main characteristics of these applications must be that subscribers may want to use them anywhere at any time and that they cannot be offered at a satisfying quality of service without the new mobile communication technology. Hence, the authors are convinced that professional training and continuing education belong to these applications [3]. Life long learning is a buzzword in the information age and it is more than convenient to study for further degrees whenever there is some spare time, rather than having to reserve time for studying.

Nevertheless, there are very different communication requirements that come along with tele-education. First of all, electronic textbook retrieval is obvious and can be done either by some sort of file transfer or by web-like HTTP-traffic. Then, for interactivity, these textbooks also contain programs to be executed at client side (e.g. Java applets) which ought to be partially reloaded only when necessary. Furthermore, studies have shown that communication between students themselves or between students and lecturers is definitely improving the quality of tele-education. Therefore, some means for synchronous (e.g. instant messaging, chat) and asynchronous communication, like e-mail, must be provided within tele-education environments. On the other hand, each lecturer must be able to offer, modify or re-organize textbooks in a comprehensive manner. Finally, tele-education should lead to some grade, so tests and exams have to be carried out, preferably also remote. And these are only the most obvious communication processes to be considered in a tele-education environment.

So when trying to set up such a kind of environment, one can either implement any communication mechanism separately or look for platforms that already provide (hopefully standardized) communication tools and a well-structured means to present lecture material for remote students. As these textbooks can be thought of as content to be provided, the idea to use content management systems as a platform for tele-learning is self-evident. But can mobile students also have benefits from utilizing content management systems? This paper tries to answer this question by introducing a tele-learning platform developed within the TiME¹ project at the Division of Communication Networks [4]. Figure 1 shows the architecture conceived for TiME.

The remainder of the paper is organized as follows. In section 2 the main characteristics of content management systems are presented. Section 3 details which functionality must be provided by content management systems to make them usable for mobile tele-education. This usability is then proven in section 4, where we describe the prototype we implemented using *PHP-Nuke*. This prototype was used to implement a first example of an electronic textbook. The experiences gained from this example are described in section 5. Finally, section 6 summarizes the main points of this paper and presents an outlook to future work.

¹ Telelearning in Mobile Environments

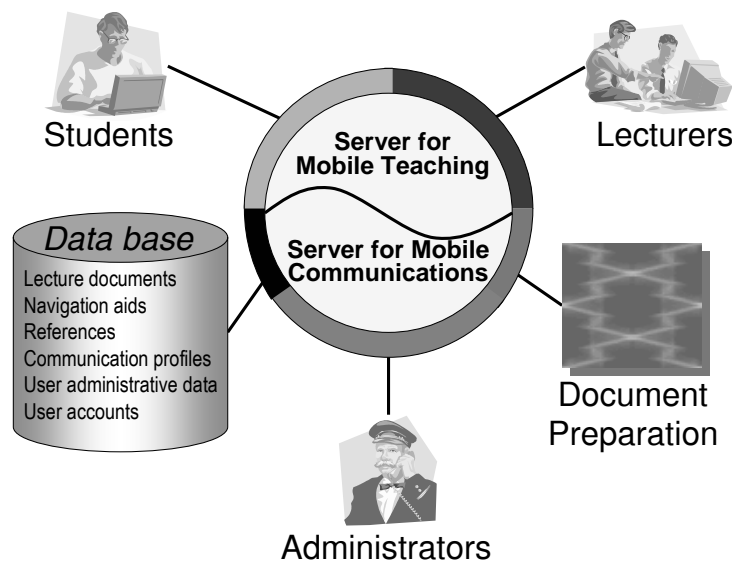


Fig. 1. The TiME Architecture

2 Content Management Systems

Content Management Systems (CMS) are used to store and subsequently find and retrieve large amounts of data. Content management systems are currently wide-spread, especially when thinking of so-called web content management systems, which enable dynamically created web pages. Content Management Systems work by indexing text, audio clips, images, etc., within a database. In addition, CMS often provide version control and check in/check out capabilities. Using robust built-in search capabilities, users can quickly find a piece of content from within a database by typing in keywords, the date the element was created, the name of the author, or other search criteria [5]. The definition of content management systems does not restrict content in any way. Content may be text, images, audio, video, program code, binary data or anything else. These systems are thus used for creation and administration of catalogues, CD-ROMs, books, web-sites or other collections of different content types.

Content management systems are implemented in different products from rather simple freeware solutions up to individually tailored high-capacity systems for huge news agencies. Generally, content and presentation are strictly separated, which means that only at the time of accessing the content, it is formatted according to given presentation guidelines.

The heart of any content management system is the data base, which can be differently realized. The simplest form is the standard file system of the operating system, so that the contents to be presented are stored in simple flat files. A

more sophisticated solution is based on data bases, starting from free databases like *mySQL* up to high-end dedicated data base servers. Which solution is appropriate depends on the amount of content to be provided: the more complex and voluminous the content is, the more administrative tools are needed, which only come with sophisticated data bases.

Nevertheless, simply using the standard file system also comes with many advantages. But then, one has to make sure that some sort of structure must be included into these files. Currently, the eXtensible Markup Language XML seems to provide a very acceptable means to enhance existing files with meta data by defining a description language for the information. Thus, cascading style sheets (CCS) or eXtensible Stylesheet Language Transformations (XSLT) are the tools of choice.

Currently, there are many content management systems available and the market is expanding rapidly [6]. In order to compare the systems, one can classify them into three groups:

Desktop Systems do not require installation on a server. They entirely run on a work station and publish static pages via a web server. These systems evolved from simple HTML editors, which were enhanced with page administration tools. Examples are *NetObjects fusion* (<http://www.netobjects.de>) or *web to date* (<http://www.web-2-date.de>).

ASP Solutions are offered by application service providers so that the complete software runs on the provider's servers. There is no need to buy a system, the service is simply rented, just like *CM4all Website Creator* (<http://www.cm4all.com>) or *i-News* (<http://www.space.net>).

Scriptbased CMS consist of a collection of scripts that are executed on a web server. Usually, these scripts are written in PHP or Perl, e.g. *PHP-Nuke* (<http://www.phpnuke.org>), *Typo3* (<http://typo3.org>) or *Zope* (<http://www.zope.org>).

3 Advantages of Content Management Systems for Tele-Education

So how can content management systems be used for tele-education? Therefore, the different users of a tele-education platform and the required functionality shall be described first.

For tele-education, three user roles can be differentiated (cf. figure 1) [7]:

- *Students* are the users the tele-education platform is designed for. The student wants to augment his or her knowledge provided through the platform and must therefore have access to the electronic textbooks or other teaching material. Furthermore, communication between students and between students and lecturers – both in a synchronous and in an asynchronous way – must be offered.
- *Lecturers* have to take care of all the teaching material offered in the environment. Thus, they must upload new courses, manage and update existing

ones and delete modules that are not needed anymore, without destroying the consistency of complete courses.

- *Administrators* finally have to deal with different user accounts and the according access rights. Especially, if the students can receive a grade through their studies, security, reliability and performance issues are the main goals administrators have to reach.

It is obvious that providing large amounts of teaching material can be alleviated through a content management system. But, in order to attract the mobile use of tele-education, the system must provide even more functionality. Mobility expresses itself in different ways:

- Changing the software environment (operating system, installed programs, etc.);
- Changing terminal equipment with changing local storage media;
- Changing networks with possibly changing quality of service QoS.

The first point leads to the conclusion that for the client as few requirements as possible should be made. Hence, the best solution is web-based because a web browser should be available in almost every software environment. The second point clarifies that the status of the tele-teaching process cannot be simply stored on the client equipment, but must be available at the server. Additionally, simple static web pages cannot be used as well, because each student has different a priori knowledge and individually progresses in the course, which makes dynamically created pages a must. Finally, the third point also underpins the need for dynamic pages: the presentation of the pages must be adapted to current QoS and to the characteristics of the used equipment.

These facts led to a script- and web-based CMS solution that is detailed in the next section.

4 Implementation

For the implementation, we chose *PHP²-Nuke*. According to the author of this system, its goal is “to have an automated web site to distribute news and articles with users system. Each user can submit comments to discuss the articles.” [8]. These features make *PHP-Nuke* an interesting platform for our tele-education system.

PHP-Nuke structures the pages it creates in three different parts [9], as figure 2 shows:

- *Modules* carry the content of the tele-education platform. They are created by the script `modules.php`, which also handles security issues.
- *Blocks* are used for dynamic user elements that must be constantly visible. A block can be used to list all the available modules, for example.
- *Skins* (which are sometimes called “Themes” as well) are responsible for the presentation of the whole system. Thus, by exchanging the skin, an adaptation for different end devices or network technologies is possible.

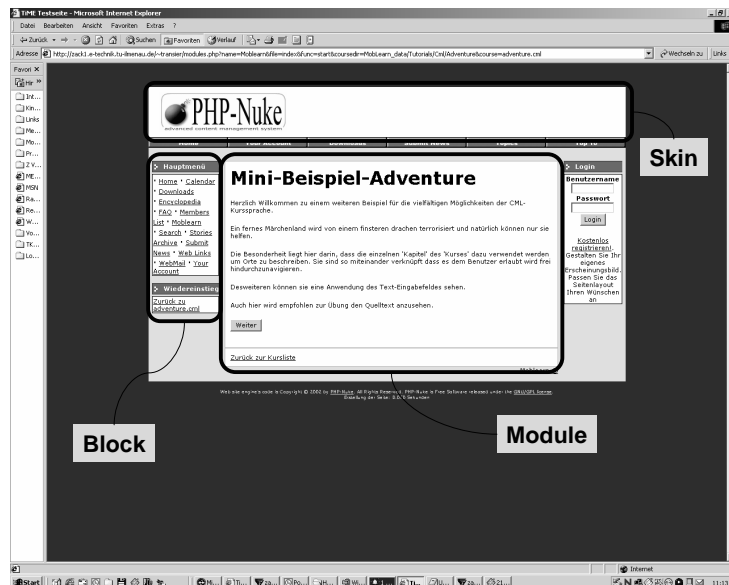


Fig. 2. Using *PHP-Nuke* for Tele-Education

Furthermore, *PHP-Nuke* already comes with a collection of useful modules. For communication, the modules **Feedback**, **Forums**, **Private Messages**, and **Webmail** enhance the functionality of the content management system according to the requirements of a tele-education platform. In order to help users and give them continuative information, the modules **FAQ**, **Encyclopedia**, **Downloads** and **Weblinks** could be easily integrated. Additionally, the *PHP-Nuke* community developed specialized modules that can be downloaded from different web servers. For tele-education, the following modules proved to be useful:

- A module **Videosystem** allows to use Windows media player as an ActiveX control within the environment;
- With the module **Gaestebuch**, the platform can be enriched with guest book functionality;
- The module **IRC_Chat** comprises a Java applet, which implements a client for Internet Relay Chat;
- Finally, the module **Eventcal** provides calendar functionality for all users.

In future, our system can be amended by even more modules that will be developed.

Using all the functionality of *PHP-Nuke* one can present online tele-teaching documents. However, interactivity, adaptivity and non-linearity is not directly offered through the system. Thus, an easy way to author and include interactive,

² Personal Home Page Construction Kit

adaptive and non-linear courses in the *PHP-Nuke* platform must be provided. Therefore, a dedicated course description language was conceived and a module based on three scripts was implemented.

The language is called *Course Markup Language* CML and is based on XML. There are several differences between CML and HTML. The main differences are as follows:

- To structure chapters within a course, CML uses `<unit>` and `</unit>`.
- CML code must be XML compliant.
- Java script code must be included via an external file.

An example for a – very simple – course written in CML is given in figure 3.

```
<course>
<coursename>Exemplary_Course</coursename>
<description>A short example for a CML file</description>
<unit id='start'>
<file src='chapter1.cml' />
<store />
<return value='button1' nextunitid='chapter2' />
<return value='button2' nextunitid='chapter2' />
</unit>
<unit id='chapter2'>
<file src='chapter2.cml' />
<return value='default' nextunitid='junction' />
</unit>
<unit id='junction'>
<remember id='start' />
<return value='button1' nextunitid='chapter3a' />
<return value='button2' nextunitid='chapter3b' />
</unit>
<unit id='chapter3a'>
<file src='chapter3a.cml' />
</unit>
<unit id='chapter3b'>
<file src='chapter3b.cml' />
</unit>
</course>
```

Fig. 3. An exemplary CML file

This course will lead to a desired sequence of chapters. First of all, chapter one will be presented. Then, the user has the choice to push either button 1 or button 2. Then, chapter two follows. Once this chapter is finished, the next one depends on the button pressed after chapter one: If button 1 was pressed, the student has to work at chapter three, version a, otherwise chapter three, version b. Figure 4 shows the structure of this course.

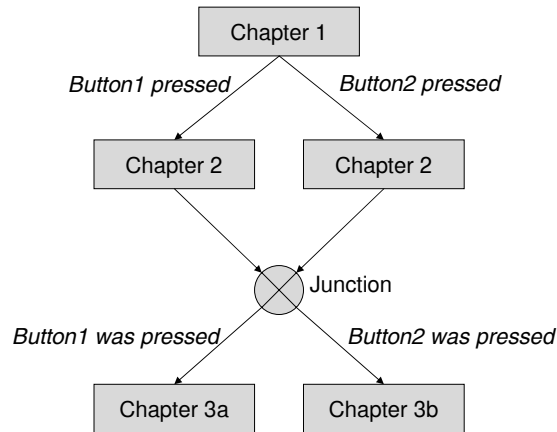


Fig. 4. The Structure of the Course

Furthermore to achieve adaptivity, a mobile-friendly skin was developed for *PHP-Nuke*. Whenever a user connects to the system, a skin that perfectly considers the characteristics of the used device will be applied. For devices with poor displays, a script called `dynpic.php` was included that adapts image size and color depth. And finally, in order to save communication bandwidth and to allow disconnected work, it is also possible to download complete courses and to study them offline.

5 First Experiences

The module described above has been used to create a real textbook: a manual for a class library. This manual was originally available as a Microsoft Word document. The following steps were made to get to a result:

1. Segmentation of the document into pages that have to be managed by the content management system;
2. Specification of the document structure i.e. the way a reader can navigate through the pages;
3. Writing the course file in CML;
4. Writing skeletons of the unit files containing interactive components to navigate through the manual in CML; each unit file represents a page containing a part of the manual;
5. Integrate the contents of the pages into the unit files.

Having in mind that the navigation as a part of interactivity is managed by the content management system the pages tend to be very small. A compromise between the support of navigation means and the format of the units has to be found. The demand for reusability of modules can be supported using the

possibility to include and control jumping between courses. This feature provides the means to define a hierarchical structure. The structure of a single course is plain, because all units and the possibilities to jump between them has to be decomposed in the course file.

For a higher flexibility in changing the structure of a course, it seems to be advantageous to separate the content of a page from the unit file representing it as a part of the course. This can be done by importing a content HTML file instead of directly copying it into the unit file. Integration of HTML-based contents in the unit file is possible but problematic, because the parser that separates the CML tags and transports the remaining text to the client browser does not accept HTML code that is generated by numerous commonly used HTML editors. In the example, therefore, `iframes` have been used.

The example showed that the implemented module (called *moblearn*) is usable to create interactive web-based textbooks if the above described problems are considered. Importing web pages into the unit files provides all possibilities that are available using static web servers including support for multimedia and Java applets etc. Additionally, it provides the functionality of the CMS including the storage of user data on a database on server side.

6 Conclusion and Outlook

In our opinion, content management systems can be used to create a tele-education platform as well. However, the functionality of existing content management systems must be amended to fulfill all the requirements – especially when trying to cope with mobile users as well.

The four main ideas presented in this paper are:

1. Content management systems can – in deed – be utilized for the management of electronic textbooks otherwise provided by a tele-education platform. However, the organization and administration of these textbooks must be according to the content management system in use. Simply taking existing textbooks and including them in a content management system is a very complex and costly task.
2. Interactivity and adaptivity are the main advantages of tele-education and must – therefore – be supported in the medium electronic textbooks are offered. Content management systems certainly provide means for that, but one has to provide easy-to-use tools for the authors to utilize these means.
3. In order to achieve reusability of electronic textbooks or teaching modules, a standardized way to describe their contents must be used. We chose an XML-based description language which allows separation of content and structure.
4. For mobile students, the content management system used to provide tele-education courses must finally provide adaptation mechanisms for different end devices or network technologies.

For the future, we will practically test the system in our continuation study course on telecommunications management, which started in April 2003. From

this practical deployment, we hope to deduce improvements especially for the user interfaces, as a broad range of both lecturers and students will be involved in this course.

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