Chapter 4
SW–Architecture for Device Independent Mobile Learning

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ABSTRACT
Mobile learning increases both flexibility and self-determined learning, often combined with a high degree of context awareness. Flexibility and context awareness includes time and location, as well as the actual individual situation. To achieve such goals, mobile learning is not just a stand-alone and independent learning environment, but is instead embedded in a broader e-learning environment. This is true for the didactic and the pedagogic concepts and the learning (content) management system, as well as the overall software architecture. XML has been proven to be adequate and a powerful technology to store content in a presentation independent manner. By defining an additional attribute inside the XML tags, it is possible to classify the content. At the same time, this will help the author generate learning material for different devices in an efficient and structured way. Also, the content can be used in different formats (XHTML, PDF, etc.) as well as with different technologies (browser, applet, MIDlet, Ajax, etc.). In order to optimise the content presentation on different mobile devices, the content has to be adapted. A necessary precondition for the adaptation process is the identification of the connected device. The classification of the identified mobile device simplifies the mapping between device capabilities and content. The ICAT (Identification, Classification, Adaptation and Tagged XML) framework addresses these issues. The proposed design patterns will help authors to generated content for such a system.

INTRODUCTION

While at home it is often more convenient to use a PC, but while on the move and using mobile learning, a learner would like to access comparable learning content with the same look and feel. So a system is necessary which is device sensitive from the point of communication functionality, interactivity, information presentation and information depth. But at the same time it must be a system which is
device independent from the point of information access, and (a-) synchronous communication possibilities.

Typically, learning content management systems are unable to handle these two opposing facts with one common data base for the content. In order to surround this problem many content providers offers multiple versions of the same information. In this way, maintaining content will be labour-intensive and therefore costly. Another disadvantage is that the authors and content developers need to have knowledge on different devices and their behaviour in order to be able to generate content using the abilities of these devices. But most authors and content developers do not have this precise technical knowledge. They want and should concentrate on the content and, in the case of e-learning and mobile learning systems, on the didactic. However, this is not on a device optimised presentation. On the other hand, people with the technical knowledge do not have necessarily the knowledge to convert the content in a proper way.

All the content pieces motivated by the didactical purpose without considering the technical or graphical constrains composes the so called generalised content.

Systems that can transfer generalised content into a device adapted version of the content are a solution for this problem. Such systems are especially important for mobile learning because of the large amount of varying devices with significantly different features and functionalities. This is true not only to support different learners, e.g. all learners within one learning community, but also to support the same learner using different equipment parallel and/or at different times. For mobile learning purposes, it is impossible to develop and adapt content for all mobile devices individually due to cost issues and author’s requirements. But new concepts and technologies enable the automation of the content adaptation process.

The following example illustrates the need for the adaptation requirement. Figure 1 shows a small XHTML page containing a SVG images (vector based, 31KB) on three different mobile devices without adaptation. The image is perfectly scaled and displayed on the first two devices (labelled a and b). Unfortunately, the third device does not support SVG, therefore the image is not visible on this device without adaptation (media format conversion). A second example is shown in Figure 2, where the XHTML page contains a JPEG image (640x480 pixels, 68KB) shown on the left. The figure on the right (labelled b) shows an adapted device version of the same image (128x96 pixels, 10KB). The advantage is that this media format is widely supported. Transmitting an image that is not adapted has the disadvantages that the scaling process is performed at the mobile device. This scaling process can cause a blur or raster effect that can make image text difficult to read. But the combination of figures and text is an important and common mobile learning means. Adaptation on the server side with specialised image processing software can reduce this bur or raster effect as well as the data amount which is an additional advantage because it can save cost/time (transmission cost/bandwidth).

XML (eXtensible Markup Language) (XHTML 1.0 Recommendation, 2000) is a key technology today with huge potential to reach the goals mentioned. XML can be and is used with quite different concepts for interactive distributed applications for both PC-based and mobile networks using internet technologies. It offers the perfect solution for handling data for device dependent presentation because it structures the data without specifying the visual presentation contrast to HTML (HyperText Markup Language) (HTML 4.01 Specification, 1999). Thus it allows reusing data to generate different device specific presentations with the help of templates.

In order to realise such an approach it is very important to be familiar with the specific device actually used. The accelerating evolution in the mobile device market has shown that a simple division into desktop and mobile presentation
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