

# Using Local Storage in Multimedia Enriched Education

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## Abstract

*Recent development in the area of information science enables the use of new technologies in many areas, including the education. Lessons are prepared from different multimedia material (like video, audio, images and text as well) to give learners better insight into the topic and to stimulate creativity in the educational process. The wide availability of the Internet access (and WWW) and the versatility of the Web browsers in supporting several multimedia formats stimulates educational application developers to use the WWW as a main data source. In this way, the applications are platform independent and available to the majority of potential learners, who may study either from their homes or in the classroom. The problem is that the remote access to multimedia data (like video) typically requires high-bandwidth network connection, which is usually not available at the learner's home. A possible solution is to store the majority of multimedia data locally and to access a significantly reduced set of data over a real-time network connection. The aim of this article is to present a Web based educational application, which uses a local mass storage device to store all multimedia data at the user's terminal.*

## 1 Introduction

Development of the computer science enables the use of new technologies also in the field of education. The introduction of the Internet with multimedia supporting services has opened up new possibilities to increase the efficiency of learning. One of the advantages of this technology is the availability of dynamic tutorials that include interactive experiments, animations, and movies. A classical education process can be transferred from a classroom to the computerized new environment. Lectures can be performed at school or as distance learning at home, which is becoming more and more important. Distance education is usually based on the World Wide Web (WWW) and can be client-server oriented, us-

ing the network connection between the client's location (usually at home or at job) and the server's side (school). A problem is that the learning process requires a real-time access and possibly reviewing the tutorials and demos. Such applications require a high-capacity network connection, usually not available at the learner's home, to transfer a huge amount of multimedia data from the server to the learner's computer. The problem is still bigger if many learners use the same server at the same time. A new technical approach to the above problem is introduced that significantly reduces the application's network requirements. Instead of transferring all multimedia material over the real-time network connection, lessons are kept on a mass storage device. The Internet services provide only the material updates, the interaction between the teacher and learners, and between learners themselves.

Local storing of multimedia lessons is not only important for distance learning, it may also be very useful in the computer classroom at school. A versatile, high capacity storage medium, however, addresses not only a WAN capacity problem. If the educational application is based on the WWW, the entire multimedia course should be stored on the server. The low-cost hard disks, which are available nowadays, are large enough to store one or a few multimedia courses, but with the increasing number of courses with a huge amount of multimedia data, a single hard disk may become too small. The another issue is maintaining the consistency of different courses on the Web server. For objective and subjective reasons the entire courseware at the server may be affected by updating a single lecture only. To avoid such situations, each teacher should keep his / her course stored on a removable medium like a tape, MO disk or DVD in the future (CD-ROMs have too small capacity for multimedia courses). Before the lesson in the classroom starts, he / she inserts the medium into the server computer and starts the Web server, which serves only for this particular course. In this case, if anything goes wrong, only the present course can be damaged. Even this is not serious damage because the removable medium can be replaced with

the backup one.

## 2 A Web Based Educational Application Supported with Local Storage

The educational application, namely a remote-education application (REA), primarily enables distance learning from home, and is based on the WWW [1]. This is the most usual way for distant learning [2, 3], which gives great possibilities for educational process. The application is implemented in Java programming language as the most appropriate language for Web and network programming. A graphical user interface is built under the Netscape and the Microsoft Internet Explorer as the most popular WWW browsers. The idea is to keep the application as general as possible. This means that the same concept of the educational tool can be used with or without a local mass storage device. To achieve such a goal, the remote-education application (REA) features a clear interface between the application level and the storage device to make the storage system transparent to the application. Usage of the REA in a computer



Figure 1: The Remote-Education Application (REA) used by students in a computer classroom environment.

classroom environment is shown in Figure 1.

The developed remote-education application is based on the client - server architecture. The client is a PC with Windows 95/98 or Windows NT operating system, which has installed a WWW browser with multimedia and Java 1.1 support. A PC with a tape drive for 13 GB linear tapes [6, 7] under the Linux operating system serves as a local mass storage system called COMBO [4, 5]. The COMBO and the client PC are connected via an Ethernet. The hardware architecture of the educational application is shown in Figure 2.

Although tapes are not widely recognized computer storage media, they are at the moment the

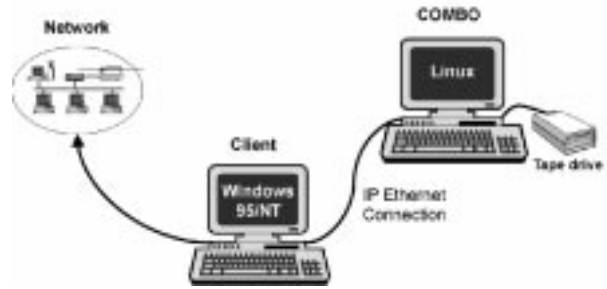


Figure 2: Hardware architecture of the remote-education application.

only removable media offering huge storage capacity at a reasonable price. In the future, DVDs may probably replace tapes as removable media in remote-education applications, especially for the home use, but the tapes will still remain very important media for large servers at schools and other institutions. In a next few years, the tapes with the capacity of 100 GB [8] will be available. This means that 50 hours of MPEG2 video can be stored on one tape.

A basic concept of the interactions between the REA, the COMBO as an example of a home mass storage system, and the network access is shown in Figure 3. The WWW server is used as the interface

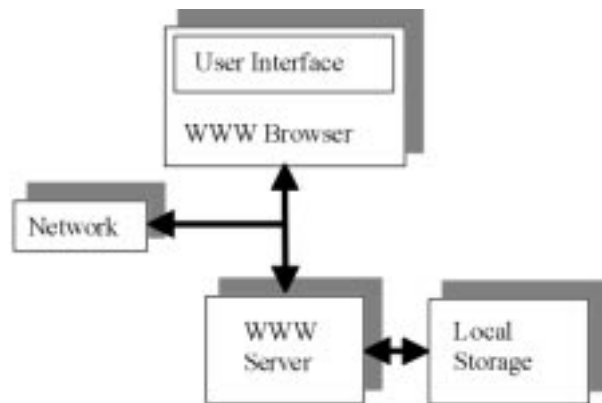


Figure 3: A basic concept of the remote-education application using local storage.

between the user interface (Web browser) and the local storage system, which is "hidden" from the user. This configuration is appropriate both in classrooms with direct connections to the Internet and at homes with only one PC client. In the case that more PCs share a single Internet connection over a local network, a modified configuration can be used, where the WWW server is replaced with a Proxy server (Figure 4). The Proxy server acts as Proxy for network requests while for local storage requests acts as a WWW Server.

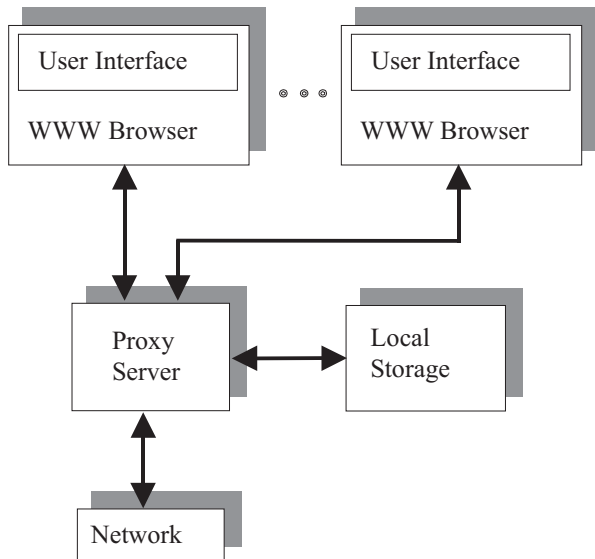


Figure 4: A modified configuration of the remote-education application using local storage.

### 3 The Graphic User Interface

The graphic user interface is a learner's gateway to the course material and it should be designed very carefully. It should be simple to use but with a clear overview of educational material and available functions. The base of each educational application is learning material. Within REA, learning material is organized in two different ways and is as such presented to the learner:

- The graphic presentation of all educational material is in a form of mind maps. The mind maps, which are similar to the human way of thinking, are graphic diagrams with different shapes and different types of connections, and therefore, they are suitable for representation of relations between topics of the course.
- The course prescribed by the teacher, is organized in a linear manner, similar to the organization of chapters, subchapters... in a book. Learners are very familiar with such a linear structure which encourages them to follow the course according to the teacher's proposal.

The mind maps are a very flexible and efficient way to show the educational material. They use different shapes, sizes, and colours to show the structure of the course and the relations between topics. The mind maps are not limited only to the lesson prescribed by the teacher, they show all available material included in the course. Multimedia technology enables more efficient presentation of the mind maps, which can be additionally described by text, images or audio and video clips. The mind maps are also links to

subtopics and HTML document pages. They can be used to navigate through the course material. When an HTML document is reached by mind-map links or by links in the table of contents, the main application's window is used to show the multimedia data. If a link in an HTML document is followed, showing some additional data, a new window for browsing is open to avoid losing the navigation through the course material.

The graphic user interface is shown in Figure 5. The interface is divided into three sections:

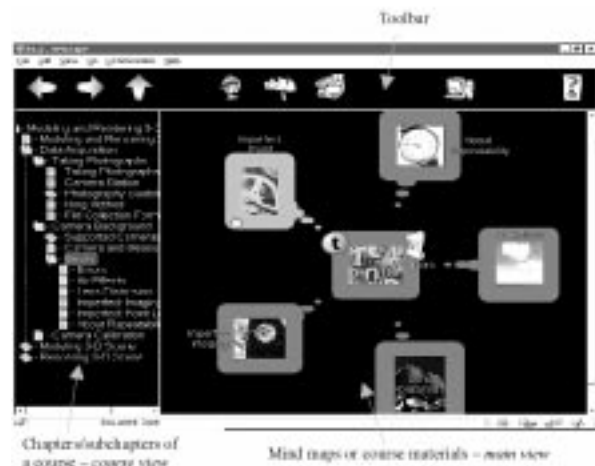


Figure 5: Application's user interface.

- The upper smaller part of the window contains the toolbar with various buttons for additional interaction with the application. Besides navigation buttons (arrows), the toolbar also contains three network-related buttons, an option button, and a help button for online help.
- The main part of the window (main view) contains a mind map of the selected chapter or the courseware document describing the chapter. A mind map is a visual representation of a concept and its related sub-concepts.
- On the left side of the window (course view), the chapter-based linear structure of the course is presented. A structure similar to the well-known Windows tree structure (representing files and directories) is used for this purpose.

Learners have several possibilities for navigation within REA:

- Display the contents of individual chapters by clicking on the chapter titles in the course view,
- Browse the courseware materials by clicking on the three arrow buttons on the toolbar,
- Move through the courseware by clicking on mind maps in the main view, and

- Navigate by clicking on hypertext links within the materials.

The first three possibilities were designed to follow the lecture material defined by the lecturer. The fourth one was added to browse the material in an arbitrary way and to explore the material which is not included in the lecture.

#### 4 Communication between the User Interface and Local Storage

The WWW server acts only as an interface between the remote-education application and the local mass storage device. The WWW server communicates with the tape controller, which controls the operation of a liner tape drive used as a mass storage device. When the WWW server receives a file request from the user interface (Web browser), it tries to get the file from a hard disk. If the file is on the hard disk, the WWW server sends it to the Web browser. However, if the file is not on the hard disk, the WWW server receives an error message and after this, it sends a request for the file to the controller. The controller should send back a message that it needs some time to retrieve the file from the tape and put it on the hard disk. After successful retrieval from the tape, it sends a message that the file is on the hard disk. Now, the WWW server sends the file to the Web browser. If the controller for any reason cannot retrieve the file, it should send an error message to the WWW server. The interaction between the simple WWW server, hard disk and the controller is shown in Figure 6.

#### 5 Conclusions

The article presents the multimedia supported educational application, which uses a mass storage device to store all multimedia data locally. As an example of the local mass storage device, the COMBO [4, 5], which combines a linear tape and a hard disk into one storage system, is used. The network connection is intended for additional browsing of the WWW, for getting new modified data from the teacher, and for communication between the learners and the teacher.

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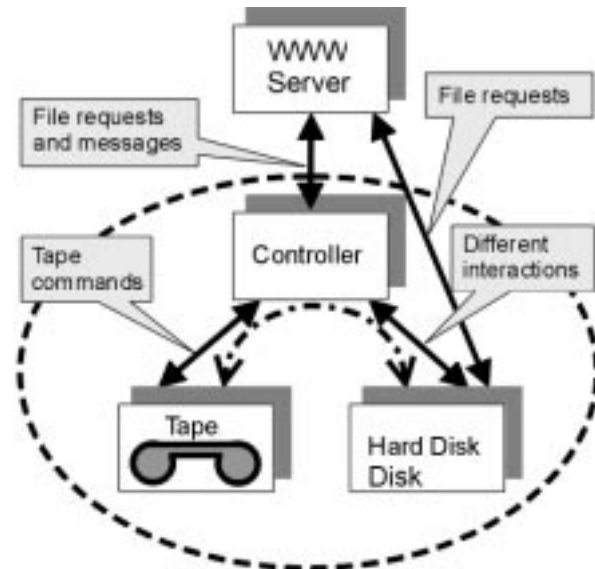


Figure 6: Communication between the WWW server, hard disk and the tape controller.

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