NETWORK BASED INFORMATION SYSTEM TO SUPPORT ODL ACTIVITIES

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Abstract
This paper presents the architecture, the design and the services of a network based Information System that supports ODL (Open and Distance Learning) activities. The ODLIS (Open and Distance Learning Information System) offers synchronous and asynchronous distance learning and MIS (Management of Information System) services to support the educational procedure. The ODLIS is a web-based application, which runs over the Internet using real time protocols.

1. Introduction

Internet technology is currently having a significant impact on work methods and practices as evidence by the rise of tele-working, web based commercial advertising and the proliferation of the commercial services offered over the Internet. In distance education, e-mail, file transfer and WWW based technologies have been used for the distribution and delivery of educational material. Most of the web based distance education has focused on asynchronous educational material. In these cases the course material is available on the web and the communication between the teacher and the students is based on asynchronous communication methods like e-mail. Unfortunately, such asynchronous approaches can only support a small subset of educational experiences. The use of synchronous learning enhances the educational procedure and extends the student's capabilities for learning. The combination of both asynchronous and synchronous learning services under an integrated environment gives students a rich educational experience. {[1], [2], [5], [9]} describe systems that offer

distance learning and [6] gives a survey of Integrated Distributed Learning Environments (IDLEs).

In this paper we propose an integrated information system which offers both asynchronous and synchronous learning services to its users. This paper is organised with the following structure: First, we present the basic requirement that such a system must meet. Then, we describe the general architecture of the system. Afterwards, we present some administrative tasks of the system. The next theme is the administration of the educational procedure. Below, we present the services of the system, which consists of the synchronous and asynchronous distance learning services. Finally, we present a case study and the conclusion of the paper.

2. Basic Requirements for the ODLIS

The following text describes the basic requirements for the ODLIS (Open and Distance Learning Information System).

The service of the ODLIS, which supports the asynchronous lessons, must meet the following basic requirements: Review of an asynchronous lesson, which is stored in the server of the ODLIS. Pause and resume capabilities during the review of an asynchronous lesson. Capability for “offline” communication (like e-mail) among the lecturers and the students of the ODLIS. Access to exercises related to an asynchronous lesson. In addition this service of the ODLIS must provide to the lecturers functionalities for: Announcement of an asynchronous lesson, announcement of an exercise related to an asynchronous lesson, access to the answers of the exercises and announcement of the results of an exercise.

The service of the ODLIS, which supports the synchronous lessons, must meet the following basic requirements: Transmission of video and audio during a synchronous lesson, shared whiteboard in order to simulate the classic blackboard, application sharing capability, chat capability, file exchange capability. In addition this service of the ODLIS must provide to the lecturers functionalities for the administration of the educational procedure.

The DBMS of the ODLIS must provide some administrative services except of ODL services. This administrative service can be divided in two basic categories: Administrative tasks for users and administrative tasks for lessons. The ODLIS recognise three user types: administrator, teacher and student. The ODLIS gives the administrator the capability to add or remove a user of the ODLIS or modify the characteristics of a user. Each teacher is responsible for the administration of the course that he creates. Each course consists of the following elements: The teacher of the course, the students of the course, announcement of synchronous lectures, educational material for synchronous lectures, asynchronous lectures, sharing space for exchange of ideas.

3. General Architecture of the ODLIS

The architecture of the ODLIS is based on the 3-tier architecture model. The ODLIS consists of: The database (1st layer - data access component) which is responsible for providing the first-born information. The server (2nd layer - business component) which is responsible for processing this information and the user interface (3rd layer - presentation component) which is responsible for the presentation of the results and the interaction with the users.

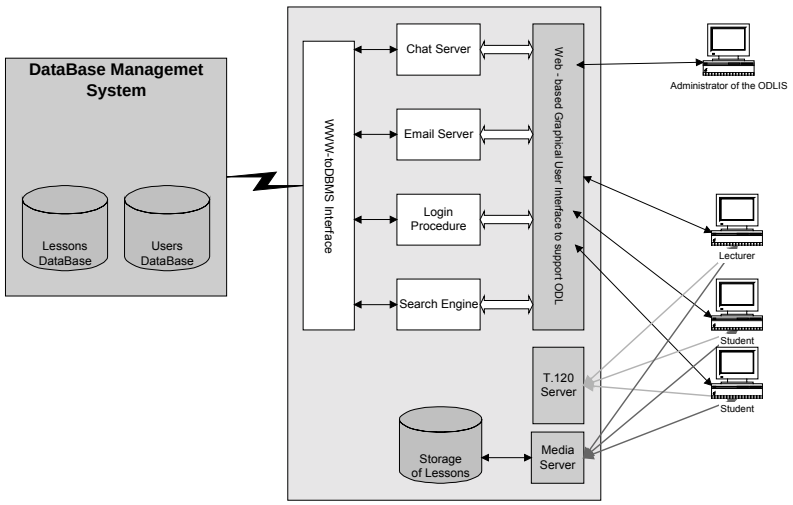

Figure 1 *General Architecture of the ODLIS*

The environment of the ODLIS consists of three modules that supply various functionalities. These modules are the following:

- The module for the administration of the environment of the ODLIS offers two basic functions. The first is the administration of the users of the ODLIS and the second is the administration of the lessons of the ODLIS. This module provides capabilities to create, delete or modify a lesson, the educational material of a lesson and the characteristics of a user. In addition this module offers the capability to search the database of the ODLIS.
- The module for the administration of the educational procedure. This module is responsible for the interaction between the students and the teachers, which is based on a discussion list with thread capabilities, web based shared workspace and e-mail. This module is also responsible for the submission of exercises to the students by the teacher and the observation of a file with the grades of each student.
- The module which is responsible for providing the synchronous and asynchronous lectures over the network. This module is responsible for the interaction between the students and the teachers during a synchronous lesson, which is based on video communication, sharing whiteboard, chat and “ask floor” capability and for the attendance of the asynchronous lessons by the students.

The ODLIS is a web-based system; the network communication between the users and the ODLIS server is based on TCP/IP protocols suite. More particularly the data is transmitted using TCP or UDP connections depending to the data characteristics. For example voice or video data are transmitted with the use of UDP connections because for this type of data, the transmission speed is more important of the reliability. For data types that reliability is critical (like text or images) the ODLIS uses TCP connections. For the Open and Distance Learning (ODL) activities, ODLIS uses protocols that support real time transmission of data and gives to its services quality of service characteristics. For the asynchronous lecture the ODLIS uses the RTSP (Real Time Streaming Protocol) protocol which offers enhanced streaming characteristics. For the synchronous lecture the ODLIS uses the RTP/RTCP (Real time Transport Protocol / Real time Transport Control Protocol) protocols which offer end to end transmission of multimedia data with real time characteristics. If the number of the participants on a synchronous lecture is too big, the IP – multicasting technique is used (in co-operation with RTP/RTCP) in order to reduce network load.

4. The Administration of the ODLIS Environment

In this paragraph we describe the functionalities for the administration of the ODLIS environment module. These functionalities include adding new users and new courses.

When a user wants to access the services of the ODLIS, he must pass the entrance procedure. During that procedure the ODLIS system makes an authentication control in order to recognise each user. If the authentication control fails the users will not have access to ODLIS services. The authentication control is based on the authentication control mechanism of the Apache web server and using the login/password logic. During the entrance procedure, the system recognises each user and gives him the appropriate authorities depending on if he is student, teacher or administrator.

Adding new user functionality is available only to the administrator of the ODLIS. The candidate users must complete a form in the web in order to be added to the users of the ODLIS. The user's information will be transmitted to the administrator, and the administrator adds the candidate user to the users list of the ODLIS. The ODLIS follows the following policy for the nomenclature of the users' logins: Each user's login must be related to the user's last name.

Adding new course functionality is available only to the administrator of the ODLIS. If one user of the ODLIS wants to add a new course he must complete a form, which is available only to users with teacher attribute. The information about the new course will be transmitted to the administrator, by the ODLIS system, and the administrator will add the new course to the course list of the ODLIS.

Courses, for uniformity reasons and for easy administration, follow a hierarchical model. As a result all the educational material for a course is stored under a directory in the web server. This directory has the following structure: A directory with the name “offline”. In this directory, the educational material of the asynchronous lectures is stored. A directory with the name “online”. In this directory the educational material of the synchronous lectures is stored. A directory with the name “wwwboard”. In this directory the information of the course’s sharing board is stored. A directory with the name “exercise”. In this directory the exercises of the course are stored. Figure 2 shows the hierarchical structure of the courses.

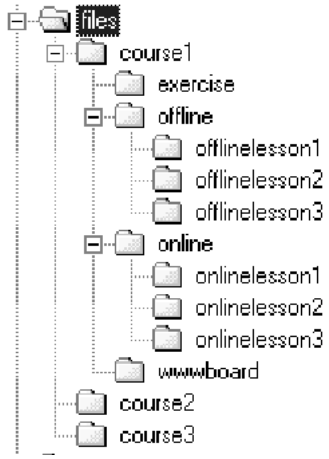

Figure 2 *Hierarchical structure of the courses*

5. The Administration of the Educational Procedure

The teacher has the capability to answer to questions of the students. The students can submit their questions through e-mail and the teacher will answer the question through e-mail. If the question is interesting and concerns many students the teacher sends the answer to the mailing list of the course. In addition the participant has the ability to communicate through the shared announcements. The teacher has the ability to post an announcement in to the share board and the students have the ability to post a question to the share board. The ODLIS offers to the participants the capability to exchange files through a web based shared workspace. Moreover the participant of a course has the capability to exchange ideas in real time through the online chat capability. All the above-described capabilities of the ODLIS implement a system with Computer Support Collaboration Work for Learning (CSCW/L) characteristics.

The teacher has the capability to announce exercises related to the course that he lectures. The exercise will be placed to the shared workspace of the course in a particular format (for example .PDF format or .doc format). The students will read the exercises and will send their answers to the teacher through e-mail and the teacher will evaluate each exercise. In addition to the above-described exercises the ODLIS will offer a multiple-choice test for each lecture

of the courses. This test will have a self-evaluation characteristic for the students. Both the results of the exercises and the tests for each student will be stored to the student's record. Each student will have the capability to check only his record.

6. The ODL Services

6.1. Architecture of the Asynchronous Open and Distance Learning (AODL) Service

Figure 3a displays the general architecture of the Asynchronous Open and Distance Learning Service (AODL).

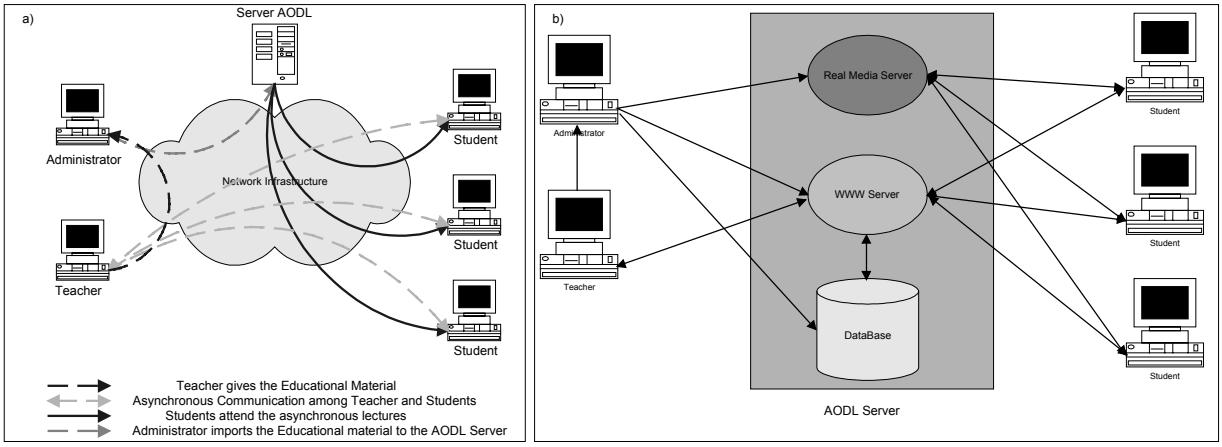

Figure 3 *The AODL service*

First of all, the teacher prepares the educational material of the asynchronous lecture and sends it to the administrator. The administrator up-loads the asynchronous lecture and the lecture is available to the students. For the implementation of the AODL service we use the architecture of Figure 3b.

The server of the AODL consists of the Real Media server, the web server of the ODLIS and the database of the ODLIS. The Real Media server is responsible for the transmission of the video over the network, the web server is responsible for the transmission of the slides and the database is responsible for management of the data.

The educational procedure is the following: The teacher prepares the educational material of an asynchronous lecture, which consists of the video and the slides. First of all the video of the asynchronous lecture must be captured in .avi Video for Windows format (.avi). Then the slides of the asynchronous lecture must be produced in Microsoft PowerPoint (.ppt) format. The next step is the synchronisation of the video and the slides of the asynchronous lecture and the conversion of it in the Real Media (.rm) format. The synchronised educational material is sent to the administrator and the administrator up-loads it to the AODL server.

The students in order to attend the asynchronous lecture must have installed to their computer the following software: a web browser with the Microsoft PowerPoint Viewer plug-in installed and the Real Media Player. Through the Real Player students can see the video and through the web browser (and the plug-in) students can see the slides.
The above-described solution uses for the transmission of the video the streaming technology. The streaming technology with the achievements of the recent years (for example the RTSP protocol) has many advantages for the transmission of multimedia data over a TCP/IP network like quality of service characteristics (with the use of buffering). The above-described architecture did not confine the way that an asynchronous lecture can be transmitted. For example a teacher can create an asynchronous lecture using a tool of his choice (for example a Macromedia tool) and suggest to the students to install the appropriate software or plug-in to their computer in order to attend the asynchronous lecture.

6.2. Architecture of the Synchronous Open and Distance Learning (SODL) Service

Figure 4 displays the general architecture of the Synchronous Open and Distance Learning Service (SODL).

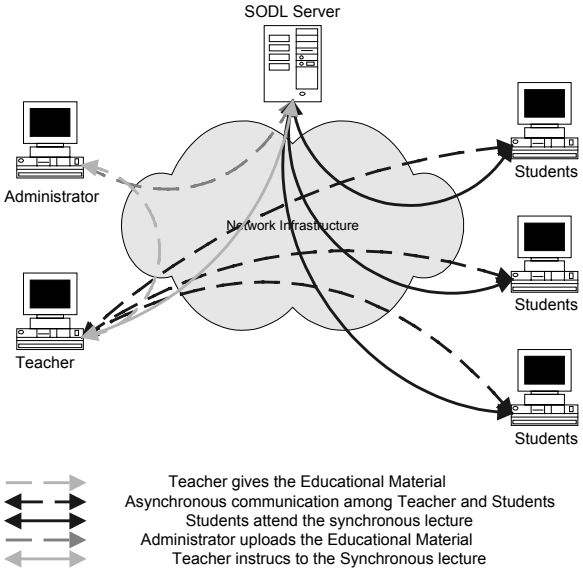

Figure 4 *The general architecture of the SODL*

First of all, the teacher prepares the educational material of the synchronous lecture and sends it to the administrator. The administrator up-loads the educational material and the lecture is available to the students. The pre-defined time and day the teacher and the student connect to the SODL server in order to realise the synchronous lecture. For the implementation of the above-described architecture we examine two approaches. In the following paragraph we describe each one and we present its advantages and disadvantages.

Figure 5a displays the implementation of the SODL with the use of H.323 reflector. In this approach the SODL server consists of an H.323 server, which is responsible for the transmission of the video, a T.120 server, which is responsible for the application and the data sharing and the web server of the ODLIS. The clients of the teacher and the students consist of a H.323 client and a web browser. In this implementation we use White Pine MeetingPoint Conference server.

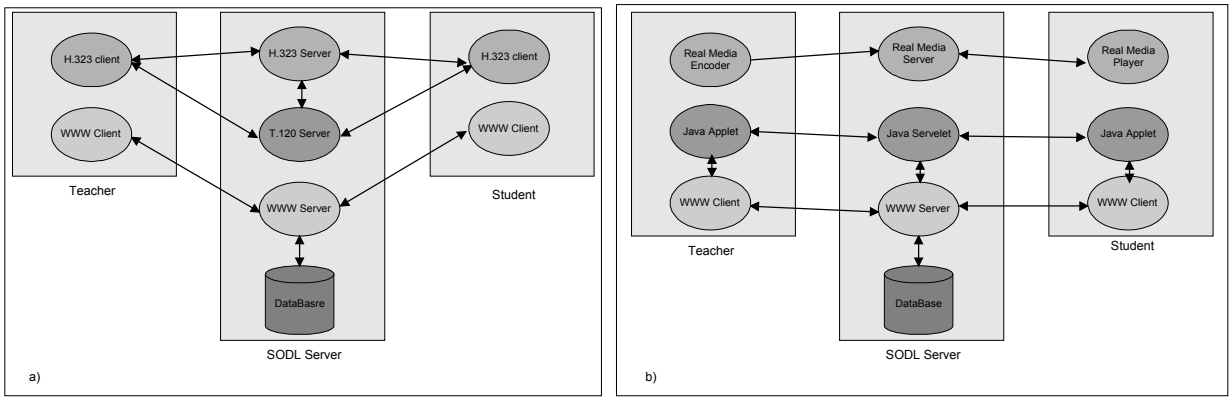

Figure 5 *Implementation of the of the SODL*

The educational procedure is the following: The teacher prepares the slides of his lecture with the software of his choice and informs the administrator. The administrator announces the synchronous lecture and he binds the appropriate resources to the SODL server for the defined time and day. The defined time and day the teacher and the students connect to the SODL server. Through the H.323 server the participants can transmit video and through T.120 server participants can share data and application. In this scenario the sharing whiteboard (that almost all H.323 clients have) can play the role of a typical blackboard. In addition through application sharing teacher can show slides with the application of his choice.

The above-described implementation has the advantage that it follows international accepted standards (like ITU H.323 and ITU T.120). In addition this implementation gives the teacher the flexibility to prepare the educational material with the software of his choice. This implementation has the drawback that it uses tools designed for videoconference and not for distance learning. This may create problems to the educational procedure from malicious students.

Figure 5b displays the implementation of the SODL with the use of Real Media and Java technology. In this approach the SODL server consists of the Real Media server which is responsible for the transmission of the video, a Java servelet (server application in Java) which is responsible for the management of the synchronous lecture and the ODLIS web server.

The Java server consists of the following four modules: The authentication control module (which is responsible for the authentication of the users), the Chat module (which gives to

synchronous lecture a chat capability that is controlled by the teacher), the Whiteboard module (which gives to synchronous lecture a shared whiteboard capability that is controlled by the teacher) and the Control module, through which the teacher controls the synchronous lecture. The users (teacher and students) client consists of the Real Media Encoder and Real Media Player for the transmission of the video, a Java enabled web browser and the corresponding applets. The communication between the Java applets and Java serverlet is based on TCP sockets.

The educational procedure is similar to the above described, with the difference that the teacher uses the shared whiteboard for lecturing.

This approach has the advantage that the teacher has full control to the educational procedure. In addition the use of the Real Media platform for the transmission of the video makes the recording of the video and the conversion of it to asynchronous lectures easy. This approach has the drawback that does not follow any international standard for data and application sharing like the ITU T.120.

7. Case Study: The University of Patras in Greece

The above described information system will be used by the Open and Distance Learning program of University of Patras in Greece. In the first phase three curriculums will operate, two for undergraduate studies and one for postgraduate studies and. More particulars will operate the postgraduate curriculum on Special Themes on Computer Science and the undergraduate curriculums on Computer Science and Neuro-Science. All the curriculums will use both asynchronous and synchronous lectures. In the future the ODL program of the University of Patras will offer more curriculums.

8. Conclusion – Future Work

With the advancement of technologies, learning and collaborative work in the future can become radically different from what it is today. Although no one can expect that educational networks will totally replace the traditional lecture. The traditional lecture has some drawbacks: students have to attend at a fixed time, the needs of students with different backgrounds cannot be met and students have no control of their learning pace or environment. The ODLIS gives a solution to the above-mentioned problems with the use of computer-based instructional technology, which has demonstrated its ability to effectively support numerous educational and training functions. Our next step is to evaluate the usage of the ODLIS through the ODL program of the Patras University in Greece.

9. Reference

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