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ABSTRACT

This paper presents a novel Networked Learning Environment (Nov-NLE); system components include Hyper-G (a networked hypermedia system) and the Internet. The first section discusses problems with the conventional university teaching model and technology-based solutions to these problems. The requirements and design of Nov-NLE are covered in the second section, including accessibility of course information and information distributed on the Internet, communication channels, and facilitation of administrative tasks. The administration/management, communication/presentation, and educational resources subsystems are described. The third section presents a prototype of Nov-NLE with the following characteristics: (1) is a distributed system in which links are stored in a separate database; (2) allows objects to be added to the system piecemeal; (3) utilizes access rights for every hypermedia collection; (4) includes sophisticated search mechanisms; (5) allows any user can annotate any document; (6) is interoperable with other first generation hypermedia systems; and (7) is multilingual. The concluding section discusses plans for the future of the project. Contains 17 references. (DLS)

Towards a Novel Networked Learning Environment

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Abstract: Education can benefit from the use of technology in the teaching process. This has been done in the past using various technologies. In recent years, computers, information systems, multimedia and hypertext systems have been used to develop self-learning environments (CAI, CAL, CBT systems). A drawback of these environments is the lack of interaction to the desired degree. With the use of new technologies like computer networks and networked hypermedia systems, new networked learning environments can be built that alleviate this problem. One such novel Networked Learning Environment is presented in this paper. Its most valuable components are the World Wide Web, the HYPER-G system and the Internet.

1. Introduction

The teaching model that is used in conventional universities is based on the oral presentation of the educational material, in form of lectures, and uses as a supplement exercises and laboratory experiments. Although other techniques have often been suggested (tutorials, cognitive learning, Socratic approach), none of them has yet succeeded in replacing lectures [Young 1995, Ferguson 1975]. The major problems that conventional universities are facing nowadays are:

- Lecture attendance of undergraduate courses, especially courses offered to senior students, decreases. At the National Technical University of Athens, in a course offered in the 9th semester the percentage of attendance is small - usually less than 60%. Some of the main causes are: (1) the fact that many students have already started engaging in professional activities; (2) the prohibitive time that it takes a student to move from his/her home to the university, because of regular heavy traffic; and (3) other occasional causes like health problems, family, personal or social reasons, etc. It should be noted here that in Greece, by tradition, higher education including course books is fee-free and that in most Greek universities lecture attendance is not compulsory.

- It is difficult for students to ask questions and receive answers outside of a lecture's appointed time. It is sometimes difficult to do so during the lectures, because of time restrictions and other personal reasons (anxiety about mistakes, modesty, shyness, etc.). It is also impossible for students to re-attend a lecture.

- The course material changes rapidly and printed course books quickly become obsolete. As a result, the instructor is often forced to provide additional lecture notes and students are often compelled to buy many books using own funds.

- It is generally difficult to locate and access useful information sources related to a course, although many such sources exist in the rest of the world.

The progress in computer and information technology offers new perspectives for education [Romiszowski 1990, Reinhardt 1995]. By proper use of *multimedia*and *hypertext*, it is nowadays possible to present the educational material without the instructor's physical presence and, furthermore, in a way that is at the same time attractive to the students and pedagogically efficient. For example, a student having a personal computer with multimedia capabilities (appropriate graphics and sound cards) and a CD-ROM unit can watch recorded video of selected parts of lectures or experiments, listen to sound, run live simulations, and all these without ever going to amphitheatre or the laboratory [Speh et al. 1994]. However, many problems still remain. A student cannot submit questions, there is no collaboration nor competition with other students and generally the student is cut off from the rest of the educational team. In a few words, there is no sufficient interaction.

Recent developments of computer and information technology in the fields of *computer networks*and *networked hypermedia systems*promise to supply with attractive solutions to these problems. It is now possible to store the educational material in a central computer and allow it to be accessed by many users at the same time, through personal computers connected to a local- or wide-area network. Availability of the educational material is thus significantly improved and the material itself can be updated regularly in a much easier and economical way. The problem of interaction is challenged in various ways with the use of both asynchronous and synchronous communication [Hiltz 1995, Harasim et al. 1995, Capell 1995]. Learning environments implemented on those grounds shall be referred to as *Networked Learning Environments* (NLEs). Obviously, the computer network is of paramount importance in these environments as well as the networked hypermedia systems and the communications tools available on the network. The use of these NLEs renders feasible the offering of education to a much large number of interested students and, at the same time, reinforces the result of the instruction [Rossner et al. 1995]. They can be viewed as steps towards the ideal of *Open and Distance Learning* (ODL).

NLEs can be implemented in various different ways. One of them is by using existing components, building upon them and creating an integrated learning environment that provides the required functionality. An experimental environment of this kind is currently under development at the Software Engineering Laboratory of the Computer Science Division, at the National Technical University of Athens (NTUA). This particular environment is the subject of this paper and will be referred to as *Nov-NLE*. Nov-NLE will be employed in carrying out a specific project in ODL, named EONT [Papaspyrou et al. 1996], within the SOCRATES programme of the European Union.

2. Requirements and Design of Nov-NLE

The following requirements have been set for Nov-NLE:

- The educational material must be widely available and able to be accessed by many computers from many different locations at the same time. It must also be hierarchically structured and use hypertext links in such a way as to facilitate and guide the users. Furthermore, the environment must be equipped with efficient authoring tools to facilitate the development of courseware and must provide an easy way to manage and regularly update the educational material.

- The environment must provide the students with a means of submitting questions and the instructor with a means of answering them. It must implement a communications channel, in which all students and the instructor will participate and discuss matters related to a specific course electronically. The content of the discussions that take place, as well as all questions and answers, must be stored in such a way that they can be reused. The environment must also support collaborative work.

- The environment must facilitate the users in their attempts to locate and access course related material that is distributed in the Internet. It must also provide with a means of communicating with other scientists and students from the rest of the world.

- The environment must facilitate the automation of administrative tasks, specify access and update rights for its users and have a friendly user interface that will make things easy for the learner.

Nov-NLE was designed for flexibility. At a physical level, it is a distributed system and uses the client-server model [Sinha 1992]. There is a server, in which all material is centrally stored, and many clients, one for each user accessing this material. The clients need not be physically located in the Software Engineering Laboratory, but they can connect to it through the NTUA's network, through the Internet or via a regular phone line, as shown in [Fig. 1].

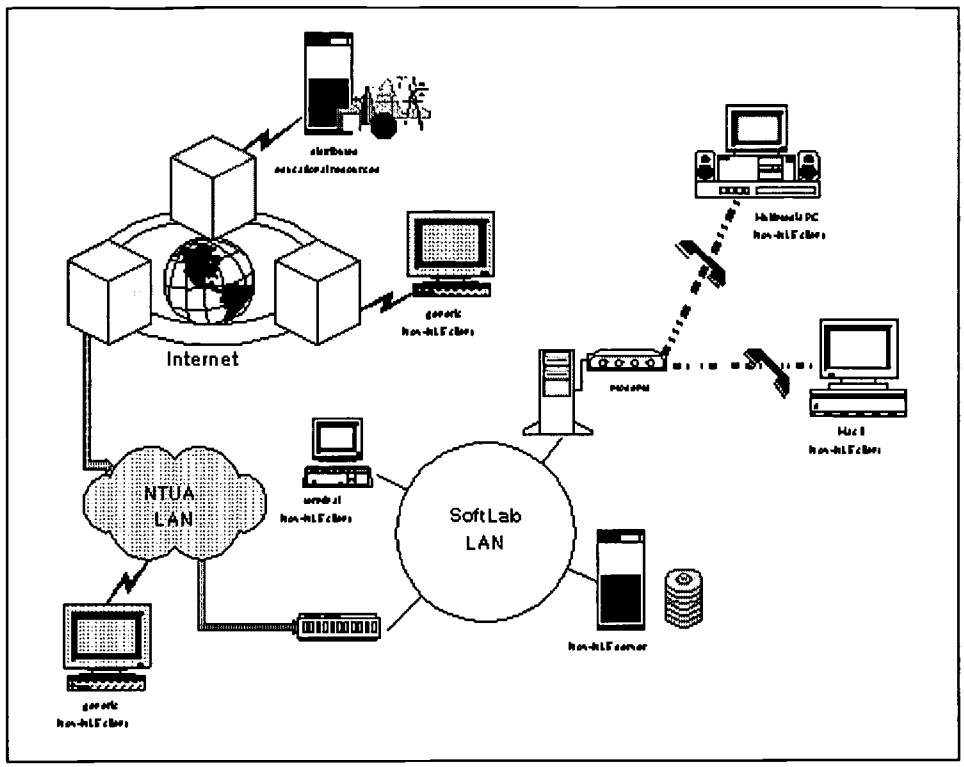

Figure 1: Client-server implementation at the physical level.

Special emphasis has been put on the structure of Nov-NLE's components, in such a way that each of the offered courses contains the educational material (electronic form of the book, lecture notes, experiments, simulations, case studies, etc.) and additionally provides access to related material that is distributed in the Internet. Nov-NLE consists of the following components, as shown in [Fig. 2]:

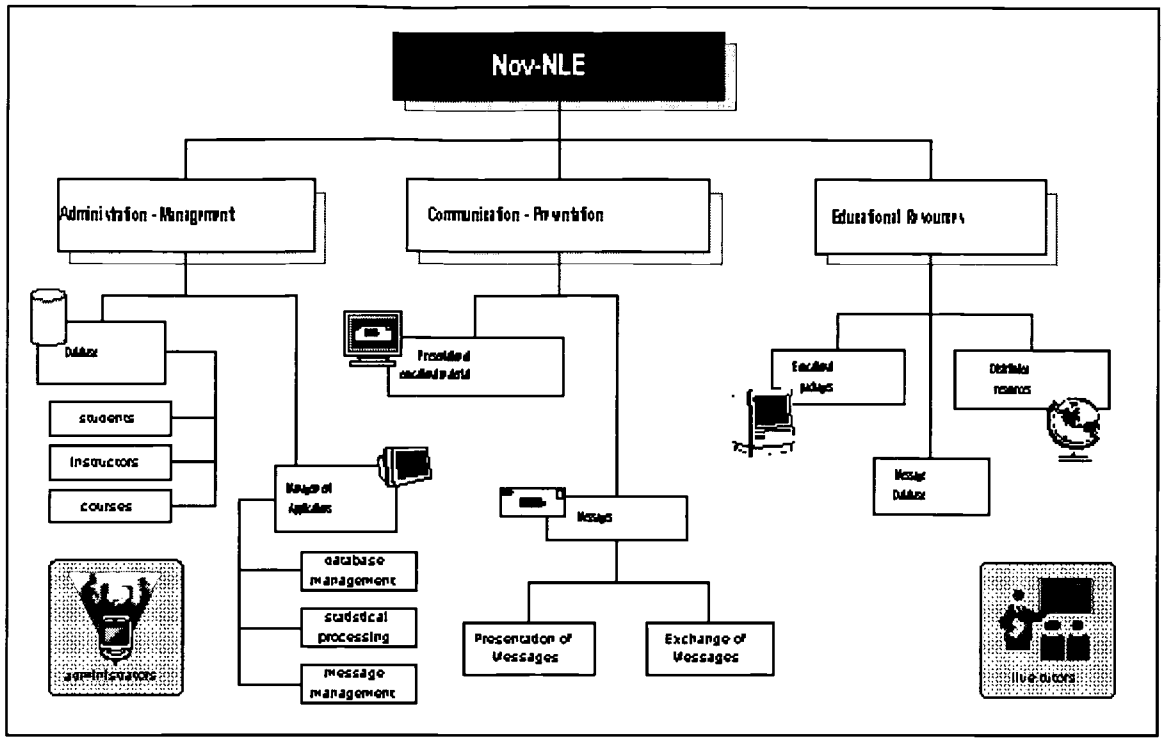

Figure 2: The structure of Nov-NLE.

- The *administration and management subsystem*, which supports the overall operation of Nov-NLE. Its main component is a database that holds all data necessary for the system's operation. Specifically, this database contains: (1) the *book of students*, which holds personal data for each student and detailed information about his/her progress in each course; (2) the *book of courses*, which holds information for each offered course; and (3) the *book of instructors*, which holds personal data for each instructor as well as other information (courses taught, supervised students, etc.). The role of this database in Nov-NLE is very important, since in addition it contains the users' access and update rights. Based on these rights it is possible to implement and operate a security control mechanism similar to that of a UNIX file system: the author of each object can specify what users are allowed to access and alter the object. The management of this database is performed by a set of management applications, to which only system administrators have access.

- The *communication and presentation subsystem*, which is responsible for the presentation of the educational material to the users of the system, as well as for the communication between the participants (instructor and students). Its major element is the man-machine interface. Since the design of Nov-NLE is based on the client-server model, this interface depends on the client that is used. Both text- and graphics-based clients are supported for a variety of platforms (IBM PC compatible under MS Windows, Macintosh, UNIX under X-Windows).

  The communication-presentation subsystem allows the exchange of various kinds of messages between Nov-NLE users. These messages offer a mechanism for communication between instructor and students and for submission of comments, questions, answers and remarks. Its proper use can partially cover the gap that is created by the lack of personal contact between students and the instructor [Harris 1995]. In order to make this message mechanism usable, three different types of messages are allowed:

  - *memos*: information that is automatically presented to a group of users as soon as they connect to the system. They are mainly used for public announcements by the instructors.

  - *private messages*: messages with a specific sender and recipient, which are not stored

permanently.

- *discussion messages*: messages of common interest, without a specific recipient, that can be read and answered to by all users. The system is responsible for storing such messages in an appropriate database, sorted by subject, in such a way that users can easily follow and participate in a discussion on a specific subject. Discussion messages are the core of the communication-presentation subsystem.

- The *educational resource subsystem*, which contains all the resources and relevant information used by Nov-NLE. It consists of three subsystems:

  - The *message database*, which stores all information about messages that are exchanged in the system. Users can seek information in comments, questions, answers and remarks that the instructor or other students have made.

  - The *educational package subsystem*, which contains educational packages for all offered courses. Each package contains the necessary educational material for a given course in hypermedia form. In addition, it can contain other information or software related to the course (bibliography, simulations, case studies, etc.).

  - The *distributed resources subsystem*, which contains references to educational resources that are distributed in the Internet. These resources can contribute to the instruction process, by means of "educational field-trips" in the Internet.

Finally, the human component of Nov-NLE consists of live tutors, responsible for the system's interactivity, and administrators.

3. A Prototype of Nov-NLE

A prototype of Nov-NLE is under construction at the Software Engineering Laboratory of NTUA. The prototype will be used for the purposes of the project EONT [Papaspyrou et al. 1996], in which participate seven universities from seven countries of the European Union. This prototype uses as infrastructure the Internet and the second-generation networked hypermedia system Hyper-G [Kappe et al. 1993]. The reason we chose Internet is because it offers a large number of services, it has a real treasure of information, and also is widely used and available today [Hesslop 1994]. The main reason we chose Hyper-G is because it possesses characteristics that facilitate the development of NLEs [Maurer 1996]. These characteristics are adequate for constructing an NLE that can meet all the requirements that were mentioned before. Specifically:

- It is a distributed system, in which the stored data can be placed at a variety of sites. There is no need for a central, dedicated server with huge amounts of disk storage.
- Hyperlinks are not stored within documents, but in a separate link database. This allows users to attach links to otherwise read-only documents (for example documents on a CD-ROM).
- Objects can be added to the system piecemeal as they are constructed.
- The system utilises access rights for every collection of hyper-documents.
- There are sophisticated search mechanisms.
- Any user of the system can annotate any document, either privately or publicly.
- The system is interoperable with other first generation hypermedia systems, such as WWW and Gopher, and with other popular Internet services, such as Telnet and FTP.
- The system is multilingual.

Software is also required for the clients of the prototype. For this purpose, existing software can be used. Possible options include the systems HM-Card, Harmony, Amadeus [Flohr 1995] or even the latest versions of popular WWW clients such as Netscape. In the first version of the prototype, whose front page is shown in [Fig. 3], the implemented components are the following:

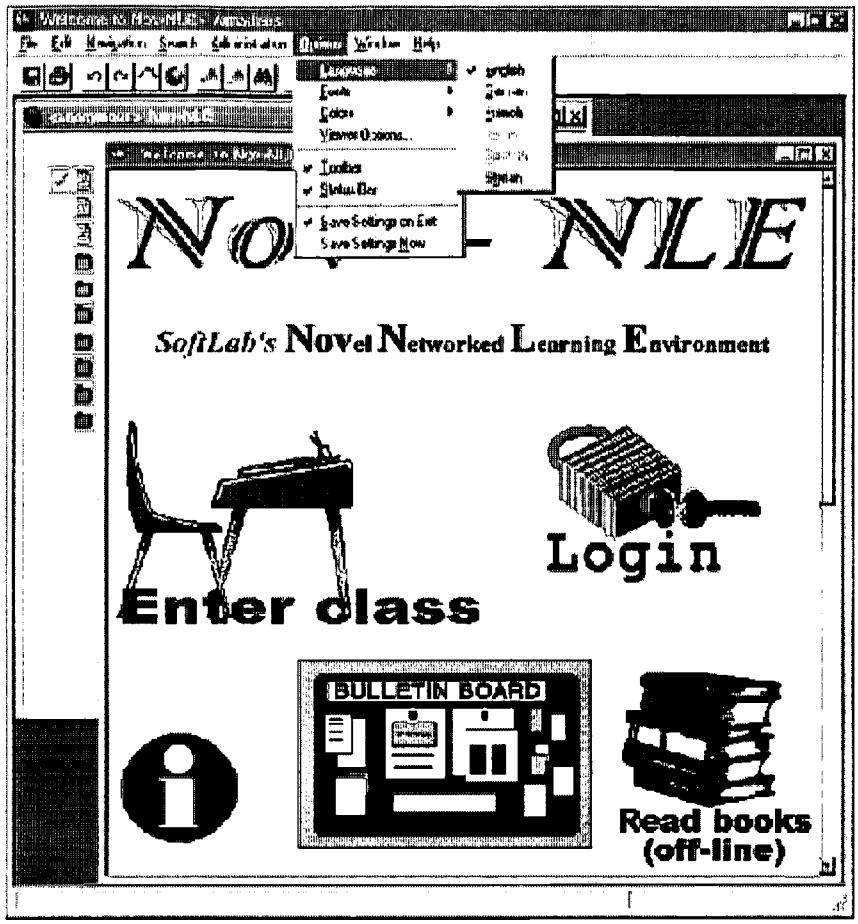

Figure 3: The front page of our prototype Nov-NLE (first version).

- *Database*: the current implementation of the database is based on a RDBMS.
- *Educational packages*: the current implementation contains one course package, with subject "Introduction to Software Engineering". However, for the purposes of EONT, each partner will develop one course package from the wide area of computer science.
- *Administration and management applications*: these applications are mainly used for the management of the database with a user-friendly graphical interface.

4. Concluding Remarks

There are a lot of things to improve concerning the state of education in our days. Some problems remain unsolved for many years and new ones arise, due to changing economic and social conditions. Higher education will profit a lot from the use of new technologies in computer networks and networked hypermedia systems. New learning environments can be built, particularly Networked Learning Environments which are the subject of this paper. The general and irreversible tendency of our age towards a future *Information Society* will help the development and use of such environments. In this Information Society, it is evident that information in digital form will require a lot of storage space and fast transfer rates. Considering the present state of information and network technology, this certainly can be thought of as a problem but its solution seems close since technology is rapidly advancing. The information highways that the European Union has committed to construct within the next 15 years [Commission 1994] are bound to help towards this direction, and the *Global Information Infrastructure* is presently a foreseeable goal. Nov-NLE is still an experimental system in an early stage of development and there are not adequate results from its use, in order to attempt an evaluation. It is certainly a step towards the implementation of usable learning environments, in the direction of the

future Information Society. Environments like Nov-NLE are expected to play a significant role in the future and should be regarded today as forerunners of much more advanced environments that will soon emerge.

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