

BASIC INTERNET SERVICES ENVIRONMENT FOR THE EDUCATION SOCIETY

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Abstract

Computer-based, networking learning environments play a significant role in the improvement of the learning procedure. Electronic communication and collaboration services provide tutors and trainees with continual, close, and efficient cooperation. An increase in the use of the Internet as a repository of resources for learning, and also as a means for delivery of specially prepared teaching materials, is a particularly significant innovation in the field of education. Educational applications are increasingly based on the World Wide Web, combining simplified access to the application and integration into a Web-based learning environment. This work presents a flexible communication and collaboration environment, developed within the framework of the ODYSSEAS project, that may be used by educators. The basic services environment presented in this paper is built upon the well-known and popular standards HTTP, SMTP, and POP3 and is accessible to the potential user through a web browser and connection to a user authentication server that will handle the user's private information, with minimal installation cost.

Key Words

Communication services over the WWW, component-based architectures, homogeneous interfaces, Internet

1. Introduction

Modern educational networks support a set of general-purpose elementary network services that provide some essential communication facilities to end users [1, 2]. These facilities include collaboration, navigation into the information resources, and interpersonal communication among educators [3].

A recent project of this nature is ODYSSEAS (Integrated Network of School and Educational Regeneration in Achaia, Thrace, and the Aegean) [4]. Its prime objective is the utilization of the experience gained by the introduction of information technology within the communities

of specialized target groups, so as to design, develop, and monitor the pilot operation of an integrated network of approximately 60 school laboratories (which will probably be used by more school units) in the geographically distributed areas of Greece (Achaia, Thrace and a part of the Aegean islands). ODYSSEAS incorporates and utilizes network technologies (i.e., local area networks and the Internet) in order to support teaching, upgrade the cultural level of pupils, and support various administrative needs of the educational community.

The basic network services that were regarded as milestones of a specialized communication process among the members of the Greek Education Society, and were implemented in the framework of ODYSSEAS, are the e-mail service, the bulletin board service, the discussion groups service, and the directory system. All together, they comprise a solution for interpersonal communication that satisfies the goals of synchronous learning theories and methods [5, 6], improving the provided education and familiarizing students with information technology. The e-mail service supports the exchange of electronic messages that consist of text and multimedia material, documents in hypertext format, and concurrent transfer of files of any type. The discussion groups service is used to provide electronic forums and discussion lists on educational topics. The bulletin board service provides reading and posting of announcements, which are grouped in different boards, according to their index. Finally, the directory system reflects the hierarchy of the entities that participate in the educational network of ODYSSEAS, and aims to provide services such as White and Yellow Pages, user identification, and bibliographic notes.

The use of network technology in education demands proper network educational communication software apart from the necessary hardware [7, 8]. In Europe, to date little effort has been devoted to the design and use of educational software to exploit the communication abilities provided by data networks. The reasons have to do, first, with the small number of schools that are connected to educational networks, and second, with a general hesitation that has been shown in the field of educational software in Europe until recently. Conventional, popular tools that support advanced telematics services, such as e-mail, are not always

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customized for educational use.

The use of the four services within the current educational project made possible a new implementation that will bypass already existing service applications designed for non-educational purposes. The user interface of the new implementation satisfies some basic principles, so as to urge the students to use the applications and to decrease their learning curve. This necessitated the design of a common user interface for all the provided basic communication services.

In particular, this common interface utilizes friendliness, which is essential for an educational tool and is achieved by the gradual presentation of the functionalities, provision of alternative choices, support of multiple communication media for integration of information, and exploration of several choices and functions. The use of allegories, guidance of the user through a handy on-line manual, recovery from mistakes, and configuration of the graphical user interface also enhance friendliness.

The vast majority of the software modules of ODYSSEAS were implemented over the Web. That is why a Web browser was chosen as the interface platform of the basic communication services. Moreover, WWW-based tools are easily accessed by any application, just through a URL. This contributes to the integration of the educational working space under the prism of the Web browser and assures the applications' easy comprehension.

Beyond the manageable user interface, the current design of the basic services applications adopts a flexible file structure that supports centralized control of the information. Therefore, the basic services applications achieve machine-independent running, so as to utilize the Web browser, minimizing installation cost and storage space. Already existing communication services tools do not utilize centralized storage of information, in conjunction with security of personal information and its easy access.

The HTTP protocol, together with the mail protocol stack (POP3&SMTP) were used as building blocks for the provision of these services. This combination links our services to a powerful application suite that is executed through a WWW interface as single Web pages and exploits all communication characteristics of international standards for message exchange. Furthermore, exploitation of a user authentication server to insure privacy (in the project the school labs are based on Windows NT technology) in using communication services in a school environment is crucial, especially when the issue is such sensitive information as private communication.

The structure of this paper is as follows: Section 2 offers a short description of the ODYSSEAS project. Section 3 highlights the major architectural principles of our basic Internet services environment. In Section 4 the functional model of each service is presented, and in Section 5, we comment on some major principles of the graphical user interface adopted by those services. Section 6 contains some directions for future work and perspectives on a new provision of basic Internet services through a VRML interface.

2. Description of ODYSSEAS Project

Project ODYSSEAS started at the end of 1996, within the bounds of the broader targets of the Greek Ministry of National Education and Religious Affairs (YPEPTH), aimed at introducing informatics in schools. The Research University Institute — Computer Technology Institute (CTI) is the main partner in the implementation of the project. The Hellenic Pedagogical Institute (HPI) and the Institute for Language and Speech Processing (ILSP, department of Xanthi) are cooperative sponsors of the implementation of the project, and YPEPTH supervises the whole progress. The duration of the project is expected to be 36 months with total funding of up to 2.9 million ECUs. ODYSSEAS is part of the program E.P.E.A.E.K. of YPEPTH.

The goal of this project is, generally speaking, the design, development, and pilot operation of an integrated network of schools composed of approximately 60 school laboratories, in the areas of Achaia, Thrace, and a part of the Aegean islands, involving the incorporation and utilization of network technologies (local area networks and Internet) in order to support teaching, upgrade the cultural level of pupils, and support various administrative needs of the educational community.

The main purposes of the project are:

- Pedagogical utilization [9] (by the whole school community in a significant number of schools situated at three different areas) of integrated educational services in three fields (teaching, cultural enhancement, and administrative support). These services are part of a computer network that will have multimedia capabilities and will connect all the schools to each other and all to the Internet.
- Development of network services at the software level and educational preparation levels in such a way that exploratory learning and the use of computing and networking technology will be supported as a means for special educational exploration, expression of ideas, and communication between all factors in the school community.
- Use of network services [10, 11] for a long period of time in order for them to be evaluated. This evaluation will be done from the pedagogical, technological, and organizational point of views.

2.1 Network Architecture

About 60 school laboratories will be supplied with modern computing and network equipment. A specially designed network architecture will ensure the needed credibility with the minimum possible functional cost. The main network of ODYSSEAS consists of three main points of access, one in each of Achaia, Thrace, and the Aegean islands. All of these three points will be connected in one main network, which will be connected to the Internet. Each one of these main access points will serve the networking needs of the schools in its own area. The schools will be connected with each other and will have access to international network

services and Internet. The architecture of the network is shown in Fig. 1.

Figure 1. The architecture of the ODYSSEAS network.

The first five schools in each of the three geographical areas (approximately 15 schools in the first phase) will be in the same urban area as the main access point (possible exceptions can be the schools in the Aegean Islands). Thus, the cost of the telecommunications will be kept low and the provided services by the Greek Telecommunications Organization will be quite reliable.

The main access point to the main network will be situated in an academic institution, which will provide connection services without charging the ODYSSEAS project. Thus, the operational expenses of the whole project will be significantly reduced.

The connection of the schools from the main access point to the main network will be done using either leased lines or dial-up connections, depending on the needs of the particular school.

A small number of schools will be selected for installation of advanced computing and networking infrastructure; the connection to the main network will be done using advanced services by the Greek Telecommunications Organization (ISDN, leased lines using high-speed data transfer and so on). This will allow advanced network services to be tested, both in the local (LAN) level and in global (urban or geographical area-WAN) level. One or two schools will be selected where advanced services with wide bandwidth are required.

The basic network structure is described in Fig. 2.

Figure 2. The basic network structure of the ODYSSEAS project.

Briefly, the school lab of ODYSSEAS will be as follows: every school lab contains 10 workstations that use Windows 95 O.S and one server that uses Windows NT 4.0. The workstations are connected to Internet through the proxy server, which is set up in the NT server. The school lab's router connects the lab modem with the main host.

3. General Architecture of the Basic Services Environment

The basic services environment that has been implemented consists of three independent applications, which correspond to the three basic services of e-mail, bulletin board, and discussion groups. A complementary application for provision of directory services serves as a directory system for the basic communication services.

3.1 Design Issues

All of the basic communication services are accessed through WWW pages, which are located in the Web server of the school or the geographical region in which the school is located. Users are able to access the pages of the basic services applications through their Web browser and

their workstation, provided they have logged on to the NT server of their school. The Web browser is actually used as a platform for access to our basic communication services environment.

The bulletin board, discussion groups, and directory services are designed in a hierarchical, two-level structure, and the e-mail service interacts exclusively with the e-mail server residing at the school NT server. The reason is that it is desirable for the school environment to be operational either with or without availability of the communication links. Therefore, the basic communication services should be operational both in the general environment of the whole educational network and in a stand-alone environment of the school. Additionally, the bulletin board and discussion groups services should always be visible to their target users, who may or may not belong to the same school. Thus the profiles concerning bulletin boards or discussion groups that may be targeting users of more than one school should be kept in the second level (i.e., at the node of the geographical region) so as to be accessible by any user, at any time, independently of the school one belongs to.

The directory system of an educational network should be able to represent the physical hierarchy of the entities that participate in it and provide services such as White Pages (i.e., search by distinguished, unique values of the entities), Yellow Pages (search by attributes of the entities), and search operations on bibliographic notes.

The architecture of the our directory system was based on the X.500 Recommendation Series of International Telecommunications Union (ITU, formerly called CCITT) that describes the provision of directory services over a distributed environment of directory subsystems.

As for the structure of the directory services application, it was also designed in the two-level fashion followed by the discussion groups and bulletin boards services: the *school level*, where a small directory system was implemented for the needs of each school, and the *regional level*, that has to cover the schools included in each region. The directory system of each school does not necessarily comply with the X.500 Recommendation Series as it is not supposed to provide directory services to users outside the school (recall that the connection of each school may be a dial-up connection, or the school server may be shut down). On the contrary, the directory systems of the geographic regions should be able to provide directory services continuously to users inside the educational network, and also to interact with each other so as to comprise an integrated directory system. Thus the regional directory systems [12] should actually be directory system agents that comply with the X.500 Recommendation Series. Additionally some matters of administration of both the regional replica and the local directory systems of each school arise, such as consistency between the two versions. Such administrative operations should be transparent to the end user, who in each case will be the school administrator.

3.2 Technological Issues

Beyond the HTTP protocol, which is the platform of our basic communication services, the e-mail and discussion

groups services are based on two widespread e-mail standards: SMTP for sending emails and POP3 for receiving e-mail. More specifically, an e-mail server is set up in the NT server of the school lab, where all users have their e-mail accounts. The provided communication services implement SMTP and POP3 clients, which connect and interact with the e-mail server. A graphical representation of the protocols used appears in Fig. 3.

Figure 3. General architecture of the basic services environment.

To effectively tackle the retrieval and storage of information, the most innovative supplementary Web technologies were used. In particular, ActiveX Platform, VBScript, and CGI Script were used, so as to overcome the disadvantage of the WWW passive protocol, HTTP.

ActiveX platform was chosen as a development component because it is based on the tested COM windows technology. It provides a wide range of effective, easily adopted features and tools, such as ActiveX controls, which contribute to the deployment of an ergonomic and fancy user interface. There is also a wide variety of ActiveX controls that constitute clients of several network protocols. It is significant that SMTP and POP3 clients of e-mail service and discussion group applications are substantially based on SMTP and POP3 ActiveX control. It is obvious from the above that ActiveX platform is more mature than its competing technology, JavaBeans. ActiveX platform is windows oriented, which makes it distinctly faster than JavaBeans, which sacrifices efficiency to achieve cross-platform interoperability. ActiveX components cooperate harmoniously with other windows applications. The only restriction is that the invocation of the advantages of ActiveX technology imposes the use of Internet Explorer4 as a Web browser.

ActiveX Platform and VBScript are suitable for local access (read or modification of personal information), whereas CGI Scripts are suitable for Web access (read or modification of shared information). ActiveX controls and the VBScript code are embedded in the html code and executed in Win95 Clients, whereas CGI Scripts, which are C executables, are executed in the Web server. This fact makes the basic services applications powerful, regardless of the large amount of information handled.

As far as e-mail service application is concerned, it takes advantage of both client-side processing (ActiveX, VBScript) and server-side processing (CGIScript), whereas bulletin board and discussion group service applications are mainly based on CGIScript.

For implementation of a directory system for the educational network, three regional directory system agents (DSAs) were considered for the major geographical regions covered by the project. These will be able to cooperate with each other through the DSP and DISP communication protocols (cf. X.500 Recommendation Series of ITU), so as to comprise a unified environment for the provision of directory services to the end user of the ODYSSEAS network.

Each of these DSAs handles the information that con-

cerns the schools of a specific geographic region. As each DSA is capable of handling hundreds of thousands of records efficiently, this is an adequate solution for each region of schools in the Greek territory. Nevertheless, due to the nature of the network infrastructure and the communication links of the schools to the nearest access points of the educational network, some caching servers should be established in each urban area that will lower the communication costs and make use of the directory system more effective. These caching servers should comply with the directory scheme of the project, and follow the proper recommendations so as to be able to interact with the regional DSAs (RFCs 1485, 1779), and will keep replicas of the contents of these DSAs that have to do with the urban area they cover, so as to avoid long-distance calls from the schools for a single retrieval of an e-mail address.

The compliance of the directory system with the X.500 Recommendation Series will assure the interoperability of this system with other directory systems that have adopted this series, as well as the potential of this specific system being integrated into a more general directory system on behalf of the Greek Ministry of Educational Affairs, that will cover the whole educational system in Greece.

Figure 4. The organizational scheme of the ODYSSEAS directory system.

3.3 Implementation Issues

The issue of security and privacy of users' profiles and e-mail folders is critical for the provision of basic communication services over an educational network. In our integrated environment, the basic communication services use, as a user authentication server of the system, the NT servers at the schools to which the users are connected before running these services. More specifically, our applications exploit the fact that a user who has logged on to the NT server of a school lab has full access privileges in his/her own personal folder in the NT server's disk space, but is discouraged from accessing other users' personal space. Moreover, the implementation utilizes the effectiveness of access to data files through both the local area network of the school lab and the Web server itself (either of the school lab, or of the geographical region in which the school resides). The concept is that private information is accessed as local information, assuring security, and some shared information may be retrieved through the corresponding Web server. Examples of private information are the user's profile and his/her message folders; shared information might be Web pages of the applications, the announcements of the bulletin boards, the profiles of the basic communication services, and so on.

Figure 5. File structure of the basic services environment.

A graphical representation of the file structure in the server appears in Fig. 5. The advantage of the architecture adopted is its great flexibility, as far as the possible extensions are concerned. The multilevel organization of information supports integration of the services. A lot of

new features can be easily added, modifications are not time consuming, and the whole file structure is efficient and clear. Furthermore, widespread accessibility is achieved, as every user is able to access the tools and personal information from a different Win95 client each time and have a uniform view, independent of his or her temporary workstation. This is achieved by the centralized control of both the personal and the control information. All information concerning the basic services applications is kept in the NT server, which is space consuming, but this makes the interaction flexible and unambiguous, as there is no need to keep multiple copies of the same information in different workstations. Finally, adopting this centralized control of information ensures high standards of security, using the security features of the NT server operating system.

4. Functionality of the Basic Services Environment

4.1 Functional Overview of the E-mail Service

The e-mail service contains three basic operations: the “Send Message” operation, where the user may send messages; the “Receive Message” operation, where the user checks new messages; and the “Messages Administration” operation, where the user may organize his or her e-mail messages into folders. Each basic operation has several features:

- *Advanced facilities for composing e-mail messages:* The user may import the body of his or her message from an already existing file. The user may also automatically add a signature and attach one or more files of any format, which will be sent together with the e-mail in base64-encoding. Alternative editors are also provided, which for now is only the word editor. The user is able to type a message using this editor, instead of using the default text editor of the application.
- *Easy tracing of a recipient's e-mail address:* The user is able to add one or more recipient addresses, just by typing the nicknames of the corresponding recipient. The application automatically searches the personal address book of the current user, and if the typed nickname has a record in the address book, that nickname is automatically replaced with the corresponding e-mail address. The address book is filled by the user and is personal. Another way provided for easily tracing the e-mail address of the recipient is use of the map provided by the directory services. It is structured in tree format and the user is able to access the e-mail address of a person by progressively locating him or her in the map structure. This is actually a friendly, graphical interface to a proprietary directory system, which is meant to be enhanced (in the next phase of the project) to a complete X.500 directory system on behalf of the project.
- *Organization of messages into folders:* The incoming messages for the user are stored in the Inbox folder. However, to achieve manageability of messages, the user is able to create several folders and move messages in the Inbox folder to the other folders.

- *Manageability of messages and folders:* Each message is regarded as an entity in the e-mail service application. The incoming messages are displayed in a catalogue grid. When the user clicks on a message, this message is selected and several functions valid for this message are activated. Thus, the user may forward, reply, delete, store, or move the current message. The same is true of the message folders: there is a tree of folders and each folder is an entity. The user may manipulate the messages of the current folder, as described above, or create a new folder and delete the current folder.
- *Flexible collection of messages:* Each time the user enters the e-mail service application, his or her e-mail account is checked for new messages. To decrease the waiting time for message collection, the application fetches only the unread messages from the account. In particular, it does not fetch messages that are already stored in Inbox from previous use of the application, but only the newest ones.
- *Maintenance of safety copies:* A copy of each sent message is maintained in a Sent folder, so it can be reused. Furthermore, deleted messages are kept in a Trash folder, and can be retrieved. These special folders may automatically be cleared periodically.
- *Modification of personal information through the application:* The user may change his or her personal signature and add/delete cards-records from his or her personal address book.

4.2 Functional Overview of the Bulletin Board Service

Every real bulletin board has a topic and every user can read the announcements and/or send personal announcements. An announcement in a bulletin board contains a brief subject, the main body, the name of the user who posted it, the date it was posted, and the date it will expire. The user may see a catalogue/tree of the existing bulletin boards, that is, their names, and is provided with the following features:

- *Access to all existing bulletin boards and announcements:* By clicking on a bulletin name of the bulletin boards tree, the user may see a list with all the subjects of the current announcement. The user may read an announcement by clicking on its subject, or move to another bulletin board by clicking on its name on the bulletin board tree.
- *Administration of bulletin boards:* Every user may create a bulletin board and be its administrator. He or she may delete this board, and post and delete announcements. Users may also insert other users, who will also be entitled to post announcements to this board.
- *Monitoring of bulletin boards:* A user may mark a bulletin board (one or more), and every time this user enters the application, he or she will be alerted if the marked bulletin board contains announcements posted later than the last time that user used the application.

- *Automatic handling of the expired announcements:* The announcements are deleted automatically, according to their expiration date.
- *Helpful secondary functions:* There is also the ability to print an announcement or store it in a file of the local disk.

4.3 Functional Overview of the Discussion Group Service

The discussion groups can be “open,” which means that every user can become a member just by asking for a subscription, or “closed,” which means that the administrator decides who can be a member. Every discussion group has a topic and an administrator who created it. All users can see and post messages to every discussion group, but only subscribed users would have access to a list with all the messages of the current group, which is called the discussion group history, and would receive the messages that are designated for the particular discussion group. The user may see a catalogue of the existing discussion groups, that is their names, the creator name, and a brief description, and is provided with the following features:

- *Access to all existing discussion groups:* By clicking on a discussion group name of the catalogue, the user may see the creator name and a brief description of the topic, and he or she can post a message into that group. If the user is subscribed, he or she can also have access to the discussion group history. The subscribed user may go through the messages by clicking on each subject, or change the current discussion group by clicking on the discussion groups catalogue.
- *Administration of discussion groups:* Every user may create a discussion group and be its administrator provided the system administrator accepts his or her request to create a mail account in order for the discussion group history to be kept. A user may delete this group, and post and delete messages. He or she may also insert other users who will also be entitled to post messages to or delete users from the group.
- *Helpful secondary functions:* The tool provides the ability to store the entire discussion group history in a new folder, which the mail service tool can fully administrate, or append a message to an already existent folder. Finally, there is also the ability to print mail or store it to a file of the local disk.

Some common functionalities of all three applications are given below.

- *Modifiable user profile:* The user is able to activate or deactivate several provided functions, configuring the system according to his personal taste. This configuration is provided through the applications, and when saved it is automatically valid.
- *Automatic recognition of the user’s login and encryption of the user’s password:* When the user enters an application, the name used for logging onto the NT server is found. The personal information space that corresponds to the current login name is traced in the NT server disk. All personal information that will be displayed is accessed from this personal information

space. The first time the user enters an application, he or she is asked to type a password, so as to ensure the safety of that user’s personal information. This password for his or her e-mail account is asked once, in the first use of the application. This password is encrypted and stored in the user’s personal space, and from this moment on the applications access and check this encrypted copy.

- *Help and tips for all functions:* Electronic on-line help is provided for the tool, in hypertext form. Several tips are displayed in the status bar of the browser, indicating the current status of the application (e.g., whether new messages were found for e-mail service) or giving a brief description of the current function (e.g., when the mouse passes over a button, a brief description of its action is displayed in the status bar).
- *Support of services by a directory system:* The map described above is substantially an electronic directory that contains, in a user-friendly form, the addresses of potential end users of the basic services applications. This construction is currently proprietary, but in the next level it will be integrated into a directory system compliant with international, widely accepted recommendations for hierarchical directory structures, such as the X.500 Directory.

4.4 Functional Overview of the Directory System Service

The major functional operations of an educational directory system are the following.

Search Operations:

- browsing among the schools that participate in the educational network through a graphical user interface, such as a map of the school regions and the schools per region
- global search of specific users according to their names
- global search of users with specific attributes (i.e., students named “Papadopoulos” in the Aegean region, the mathematicians in a specific school, etc.)
- local search of specific users according to their names, in the same school
- local search of users with specific attributes (i.e., students of the third class, educational particulars)

User administration operations, such as:

- addition or deletion of new users with specific attributes
- addition or deletion of a whole class of students
- promotion of a whole class at the end of the year

5. Graphical User Interface

The environment has been designed so as to provide a great degree of flexibility without causing navigational difficulties and cognitive overload for users. The workspace has been carefully divided into sections that interact with each other, avoiding distraction. Menus, button bars, and helpful tips prevent the user from being confused and make the applications easy to use for everyone who has prime experience in navigating through the Internet.

Figure 6. E-mail service application.

Although the basic services are used independently, they are designed with consistency, that is, they all adopt similar functions for primitive operations that concern all these services. Consequently, the same actions have similar results in different applications. From the implementation standpoint, all functions are important. Often, however, a relatively small number of functions account for the majority of usage. In order to reduce the learning curve of the applications, their capabilities are presented in an orderly manner, so that the most commonly used functions are presented first and the most sophisticated ones are less highlighted, and sometimes even deactivated. Following this concept, each basic service contains one or more basic operations. Each basic operation is implemented in a different page. For example, in e-mail service, the “Send Message” and “Receive Message” operations are located on two different pages. At the top of the e-mail service environment, a Current Page Bar is located, which indicates the current basic operation. The user may alternate the basic operations’ pages. Each basic operation contains some functions. These functions are represented in a toolbar on the page of the basic operation where they belong, and they are valid only when their basic operation is active.

Figure 7. Bulletin board service application.

The gradual presentation of the complete set of potentials for every basic service is achieved through provision of several scenarios/versions for each service. In this way, the user will familiarize himself or herself with the most substantial functions, using the easiest scenario, and gradually become acquainted with all the functions provided, using the most elegant scenario. Consequently, users enjoy a feeling of immediate confidence in their ability to master the new applications.

The advanced users are responsible for configuring the settings and selecting personal preferences, which enhances their sense of control and encourages them to take an active role in understanding the applications and how they work. Functions that may cause a serious or unrecoverable loss of work warn users of the consequences and request explicit confirmation.

Figure 8. Discussion group service application.

Several allegories are used that relate computer entities to real-life features, which is the easiest way for a student to comprehend complicated computer and network terminology. For example, the structure of the bulletin boards is represented as a tree. Another issue is the use of nicknames. The student is not obliged to type the e-mail address of a recipient, which is a difficult-to-remember string. He may type his nickname, and the email address will be jotted down automatically. He may also click on the search globe, where he would geographically spot the recipient’s name and progressively access his e-mail address.

Several functions that may cause a serious or unrecoverable loss of work warn the user of the irreversible conse-

quences and request explicit confirmation. Warnings such as “Are you sure you want to erase this Message Folder?” protect the user from inadvertent destructive operations and yet allow them to remain in control of the application.

To avoid excessive errors, several buttons that correspond to several functions are temporarily disabled when using them would be inappropriate. Disabled buttons provide a visual cue that they are not currently operable.

An Undo function is supported, which supports learning by trial-and-error and minimizes the cost of errors. The undo function allows users to retract previous actions, and fosters a spirit of exploration and experimentation that is essential.

6. Conclusion

The design and development platform allows for easy enrichment of the user interface. Several ActiveX controls can be used, so as to give the implemented applications several Windows 95 utilities.

- The applications could use Drag and Drop Utilities, so that the entities (e.g., e-mail messages) could be easily copied or moved.
- Several abbreviations could be associated with the most frequent functions.
- The menu choices and messages could adapt to the user’s native language, enabling multilingual support facilities.
- VRML technology could be embedded. VRML worlds can be interactive and animated; therefore this technology could contribute to the development of an impressive tutorial.

Furthermore, additional network services [13–15] could be designed and implemented, rendering the basic services environment an integrated interpersonal communication tool suite that will cover all educational and collaborative demands in terms of a school laboratory. Design goals could aim at the provision of the following additional network services:

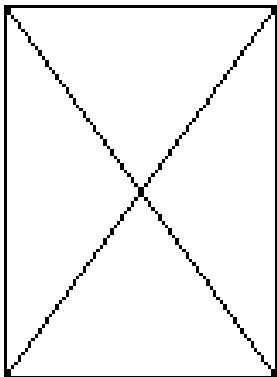
- *Telnet service*: This service permits connection to a remote computer in the network. It will be accomplished by a Telnet client and may be used for accessing remote libraries.
- *File transfer tool*: This network service allows for essential file transfer operations, such as uploading and downloading one or more files. It may be implemented as an FTP client.
- *Integrated virtual course service*: Users could be grouped in terms of classes or lessons and a uniform user interface would simulate all entities of a real class, that is, students, teacher, exercises, transparencies, and learning material. Thus, a tool that resembles a real class would arise. In this tool, emphasis should be on the provision of on-line communication between users, that is, the development of a chat element, where users could chat; a whiteboard element, where they could paint; and a file exchange element, where users could cooperatively compose a document or exchange exercises and learning material. Utilizing the multimedia technology and its powerful role in education,

this course environment could host specially prepared multimedia lectures, where all users will have access, and audio-video communication between users.

References

- [1] C. Bouras, D. Fotakis, A. Katanou, A. Konidaris, S. Kontogiannis, A. Sevasti, & E. Stephanou, Major principles on the design of an educational network, *Open Classroom II Conference*, Crete, Greece, 1997, 359–366.
- [2] C. Bouras, A. Gkamas, V. Kapoulas, P. Lampsas, & Th. Tsiatsos, A platform for the implementation of the services of an educational network, *15th IFIP World Computer Congress-Teleteaching '98*, Vienna, Austria, 1998, 159–169.
- [3] J. Blando, B. Means, T. Middleton, C.C. Morocco, K. Olson, A. R. Remz, & J. Zorfass, *Using technology to support education reform* (U.S Department of Education, Office of Educational Research and Improvement, 1993).
- [4] C. Bouras, A. Hadzilakos, M. Koutlis, N. Panopoulos, & P. Spirakis, ODYSSEAS: The Greek educational network for secondary education, *EUROAMERITEL'97 Conf.*, San Jose, Costa Rica, 1997.
- [5] B. Collis, P. De Vries, W. Veen, & F. Vogelgang de Lier (eds.), *Telematics in education: The European case* (De Lier: Academic Book Centre, 1994).
- [6] R. Mills & A. Tait (eds.), *Supporting the learner in open and distance learning* (London: Pitman Publishing, 1996).
- [7] D. Minoli, *Distance learning technology and applications* (Norwood, MA: Artech House, 1996).
- [8] W.J. Pelgrum, *New information technologies in the education systems of the EC member states*, Synthesis Report, European Commission, 1992.
- [9] J. Richardson, *Information technology: A new path to creativity in education* (France: ESKA Publishing, 1997).
- [10] J. Adam, Interactive multimedia: Special report, *IEEE Spectrum*, 1993, 21–39.
- [11] W. Stallings, *Data and computer communications*, 2nd ed. (MacMillan Publishing Company, 1988).
- [12] M.T. Rose, *The little black book: Mail bonding with OSI directory services* (Prentice Hall, 1992).
- [13] B. Furht, *Multimedia tools and applications* (Florida Atlantic University: Kluwer, 1996).
- [14] B. Furht, *Multimedia systems and techniques* (Florida Atlantic University: Kluwer, 1996).
- [15] C. Bouras, D. Fotakis, V. Kapoulas, S. Kontogiannis, P. Lampsas, & A. Tatakis, Using multimedia/hypermedia tools over networks for distance education and training, *Journal of Educational Technology Review*, 7, 1997, 20–26.

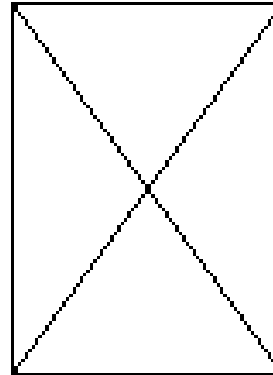
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Christos Bouras obtained his Diploma and Ph.D. from the Computer Science and Engineering Department of Patras University, Greece. He is currently an Assistant Professor in that department, a member of BoD in the Computer Technology Institute (CTI), and head of Research Unit 6 at the CTI, Patras, Greece. He is a researcher in the area of networks, educational technology,

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