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Université d'Ottawa • University of Ottawa

**The University of Ottawa
Faculty of Business Administration
MBA Program**

Telelearning Via The Internet

By

© Rafa Kouki

**A Thesis submitted in partial fulfillment
of the requirement for the degree of
Masters in Business Administration
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***To my beloved parents,
my cherished Fattouna, Sannouta,
and Haythouma al Azaiez***

“Like the PC, the INTERNET is a tidal wave. It will wash over the computer industry and many others drowning those who do not learn to swim in its waves”

Bill Gates. Times of India, 23rd Aug

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Abstract

Being the largest and most powerful computer network in the world, the Internet combined with its different tools and technologies, have brought in momentous changes in the way we think, create, store, disseminate and acquire knowledge. Being one of the very first milieus to be influenced by these revolutionary transformations, the academic environment has been witnessing the rise of a new form of teaching and transferring knowledge; that is telelearning via the Internet. Within the last two years, Internet-based telelearning has been increasing in popularity among the Internet community. Already hundreds of on-line courses and degrees are offered on-line by conventional and virtual Internet-based institutions. It is mainly the Internet's flexibility, robustness, wide reach and low involved costs, which are behind the increasing prevalence of this new form of delivering education. However, a certain number of problem areas are still facing telelearning practitioners, which should be worked on and resolved soon, if most of the expectations of a universal effective and successful telelearning environment are to be realized. Some of these issues include Internet security, copyrights of digital material, and accreditation of on-line degrees and programs.

This thesis includes four parts. Part I includes a description of a variety of synchronous and asynchronous Internet tools, as well as their advantages and drawbacks. In part II, some case studies of Internet-based telelearning applications are described, in addition to a discussion of the results of two investigations about the current implementations of the Internet tools within a telelearning setting. Part III provides an analysis of the different economics of telelearning which comprises costs related to both: the students and the institution. Finally, in part IV a number of Internet issues relating to telelearning were examined. These include: security and policy issues such as copyright of on-line material, accreditation of on-line degrees and virtual institutions, on-line academic fraud, and evaluation of the Web's material.

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List of Acronyms

ADSL	: Asymmetric Digital Subscriber Line.
B-channel	: Bearer channel.
BRI	: Basic Rate ISDN.
CGI	: Common Gateway Interface.
CSU	: Channel Service Unit.
D-channel	: Data Channel.
DNS	: Domain Name System.
DSU	: Data Service Unit.
FTP	: File Transfer Protocol.
GIF	: Graphics Interchange Format.
HTML	: Hypertext Markup Language.
HTTP	: Hypertext Transfer Protocol.
HTTPS	: Secure Hypertext Transport Protocol.
IP	: Internet Protocol.
IRC	: Internet Relay Chat.
ISDN	: Integrated Services Digital Network.
ISP	: Internet Service Provider.
kbps	: kilobits per second.
MBONE	: Multicast backBONE.
Mbps	: Millions of bits per second.
MIME	: Multipurpose Internet Mail Extensions.
MOO	: Object-Oriented MUD.
Mrouter	: Multicast router.
MUD	: Mulit User Dimensions or Dungeons.
Nevot	: Network Voice Terminal.
NV	: NetVideo.
PDF	: Portable Document Format.
PEM	: Privacy Enhanced Mail
PGP	: Pretty Good Privacy.
POP	: Post Office Protocol.
POTS	: Plain Old Telephone Service.
PRI	: Primary Rate ISDN.
RSVP	: ReSerVation resource Protocol.
RTP	: Real Time Protocol.
SLIP/PPP	: Serial Line Internet Protocol (SLIP)/Point to Point Protocol (PPP).
SSL	: Secure Socket Layer.
TCP	: Transmission Control Protocol.
TTL	: Time To Live.
VAT	: Visual audio Tool.
VRML	: Virtual Reality Modeling Language.
UDP	: User Datagram Protocol.
WB	: WhiteBoard.
WWW	: World Wide Web.

INTRODUCTION

1.1 Trends in education:

In recent years, our societies have been undergoing fundamental changes, as we've been shifting from a predominantly manufacturing oriented economy towards a new service and information technology oriented economy. A major transition from an industrial age towards an information or a digital age. A new era where knowledge has become a commodity as well as one of the critical elements in the creation of economic values and distribution of wealth in a society.

The main central engine of these paradigm shifts towards the information age, is the Internet. This computer technology which can be unmistakably described as the main revolution in information technology, after the personal computer.

Before discussing the momentous effects of this medium, we first give a brief description of the different forces and interrelated pressures which are driving the progression towards the information age, and their main outgrowth: the vital need for lifelong learning, constant training and incessant skills upgrade, in order to hold up under the new conditions of the dynamic environment.

First, the rapidly advancing technologies, primarily in the information technology and computing field, and the revolution in processing power and ubiquitous computer networks, are fostering the emergence of new global systems of intercommunication, learning and disseminating knowledge, where distance has become an insignificant factor for the dissemination of knowledge and information.

Next, the world of business is facing a more global economy, where market barriers are dismantled and a single worldwide market is being shared by all business all over the world. If businesses are to compete, survive and prosper within the new highly competitive global environment, flexibility and quick adaptability are the vital key assets which should be acquired.

Furthermore, customers are becoming better educated about the products they receive, and are demanding more customized and just-in-time services, which resulted in increased tension on businesses. The wider availability of similar providers, urges businesses to present their customers with the best services, otherwise they will easily switch to competitors.

The shorter life span of information and the rapid technological developments, drive the need for well designed business strategies, where continuous learning programs are central. These programs should emphasize the need for constant training and retraining of workers, in order to ensure that the work force is implementing and keeping up with the new technologies, and that they are effectively coping with any unpredictable incidents.

The escalating costs of training and education programs, especially when the work force is scattered all over the world, however, suggests the use of more cost effective methods for a competent delivery of education. The key solution for this issue, which can assure that the same message is delivered to all workers at times to suit their convenience, is by applying the new competitive on-line networking technologies, with the Internet leading the pack.

Besides these factors, and in view of the increased competition in the market place, businesses have started putting new constraints on their work forces. Recently, many companies have reduced their work force to a minimal essential number, and have set higher skill levels for their new recruits. These new conditions have been actively reshaping the work force. To cite an instance, many average workers, these days, are frequently changing jobs and, in many cases, even careers. The increased diversification and global aspect of businesses are bringing in new sources of workers, and therefore putting new risks and challenges for workers as they strive to secure their current jobs.

Further, the required skills for success are becoming more varied, and the minimum skill level is increasing, with flexibility, quick and sensible decision making as the key talents. With all these conditions, most of the workers have already started to work hard on expanding their knowledge base and on acquiring new skills.

In consideration of these circumstances, lifelong learning is quickly becoming the norm and the critical factor of success for individuals and organizations.

The academic environment is also facing many challenges, today. First, emerging telecommunication technologies, in particular the Internet and its different tools including multimedia, virtual reality and real time interaction, are having a significant impact on education and the traditional learning processes. The Internet is today being employed by conventional campus based universities plus new virtual academic institutions.

Likewise, individual expectations and demands concerning the nature and dissemination of educational services are also changing in response to the technological innovations, primarily the Internet. Increasingly academic institutions are expected to offer instructional and support services based on the convenience of the learners, i.e. education should be delivered to learners at the time and place determined by the learner. Such highly personalized learning is easily granted by several new technologies, principally the Internet. Already several educational institutions have started implementing this new strategy, and are offering several on-line Internet-based programs like undergraduate and graduate degree programs, continuing education and on-line staff training and development. More detailed case studies are discussed in the coming chapters.

Educational institutions also need to prepare their students for the new information society, by implementing the new technologies and integrating them into their systems. Moreover, as a high portion of the work force will need retraining during the coming years, new continuous education and professional programs are being designed.

At the same time, educational institutions are facing several economic challenges, including shrinking budgets and reduced funding, facility deficits, faculty shortages and insecure faculty resources. Similar conditions are forcing institutions to look for creative ways to provide high quality education with more limited resources, to look for new methods to transfer knowledge to non traditional students, and to make learning resource available on-line for open public access.

Several alternatives have been implemented by some academic and business organizations in favor of overcoming the above mentioned issues and challenges. These involve:

- video-conferencing (one way video, two way audio, or two way audio and video) via satellite, telephone, cable or microwave links;
- desktop-conferencing (asynchronous and synchronous interactive communication using text, audio and/or video), and
- the Internet (also asynchronous and synchronous interactive text, audio and/or video).

The various limitations and issues related to the two first technologies compared with Internet's singularities, strongly promote the latter to be the best alternative for a flexible, wide access and high quality instruction and learning settings. Discussions of the different aspects, problems and possibilities of video-conferencing and desktop-conferencing is beyond the scope of this essay.

1.2 Telelearning and the Internet:

Being the largest, most powerful computer network in the world, the Internet and its different tools, primarily the World Wide Web, has brought in momentous changes in the way we think, create, store, disseminate and acquire knowledge.

The Internet with its powerful tools and characteristics, such as the ability to carry on both interactive and non interactive conversations, hold text based or audio-video live conferences, and integrate multimedia elements of text, graphics, sounds, music, virtual reality, animation and more, has been bringing in exciting opportunities to the educational environment for a more effective dissemination of knowledge.

Based on a survey held by Baruch College-Harris Poll, commissioned by Business Week (BW), which was held during the period of April 11 to 16, 1997, the highest ranked primary activities of the respondents were research (for 50% of the respondents) and education (for 37% of the respondents). Moreover, following a survey held by FIND/SVP, on October 21st, 1996, 57% of respondents believed that "the Internet has a great future as a medium for education", while 70% believed that the future of the Internet is mostly for information access, and 68% presume that it will be mostly used for communication.

Despite these figures, the exact assessment of the Internet phenomenon is a process that the New York Times technology writer Peter H. Lewis describes as being akin to "the proverbial bunch of blind men trying to describe an elephant by feeling the different parts of the beast". However, even if it is nearly impossible to get exact figures, some survey results still give an indication of the trend and the predominant aspects of this medium.

In addition to the increasing number of educational institutions with on-line Internet connections, fast databases and libraries of information are already accessible on-line. New software tools are significantly simplifying access problems and bringing in limitless information material at the fingertips of learners.

With the Internet, schools have equal access to information from almost anywhere in the world. The exponential growth of the Internet, and the continuous developments of its invaluable tools and resources, coupled with its powerful characteristics, such as cost effectiveness, the easy worldwide access, and the up-to-date immense information resources, have been promoting several opportunities for more creative ways of teaching and learning. Educators and students alike are exploring new ways to incorporate the Internet in their education experience.

First, the easier access to the Internet information resources, the ability to find timely information from different resources such as the on-line databases and libraries, and the easier communication with experts and peers worldwide, has been providing a more active learning environments for learners. Using the Internet, students are actively engaged in searching, collecting and analyzing information, rather than passively listening and receiving lecture material. They are also strongly encouraged to collaborate with their peers on group projects, allowing students to have more opportunities to discover new ideas and personalities.

On the other hand, teachers are also finding a potential for collaboration to enrich their professional experience by interacting and exchanging ideas with their peers from different areas around the world and by accessing remote information resources. At the same time, the role of teachers in class is reshaping as they are acting more like motivators and facilitators, rather than just being information providers.

With all these transformations in the educational environment, along with the escalating number of colleges, universities, schools, companies, research institutes, and independent individuals who are connecting to the Internet, a new phenomenon has started to prevail, which is telelearning via the Internet. Its prime practitioners, as its name implies, are using the Internet for the delivery of a wide range of degree and non degree courses and programs to students from all around the world. The Internet's unique characteristics have significantly assisted educators and students to overcome time and distance factors, in favor of setting up a global classroom and collective research media.

In view of the continuous upgrades and improvement in the Internet technology and bandwidth, combined with the increasing need for lifelong learning, as well as the economic constraints, most educational institutions will have a telelearning component in their programs to disseminate knowledge to remote locations, which can be as nearby as student homes, across provinces and states or across the world. Already, many schools and universities all around the world are working hard on reinventing their educational systems in order to remain relevant and to assure their existence. In fact, if these traditional institutions don't do so now, it is very likely that competitors from all around the world or any new non traditional education providers will soon take over their "students market".

Schools which have started deploying this medium for telelearning, have accordingly reshaped their mission statement and their "target" student categories to comprise:

- current college and university students in traditional education paths who are interested in obtaining a degree in order to broaden their opportunities in the job market.
- non traditional students, who are individuals wanting to broaden their knowledge base and acquire new skills and qualifications, in order to update their competencies or enhance their professional practice.

Usually, these do not have big concerns about the degree. Their main goal is the better qualification.

The new on-line services, as will be discussed in later chapters in more details, fall into three main categories:

1. The Internet as the educational institution's information desk: where information regarding courses, registration procedures and fees are available on-line
2. The Internet as a repository of lecture related materials and references, used for:
 - a) conventional face-to-face classes. In this case, the course is taught in the classroom, while reference material and out of the class teacher support is provided on-line.
 - b) on-line virtual classes, where all the class activities are performed on-line.
3. The Internet as the medium for on-line courses that are delivered on-line to remote students.

In this thesis, we will be dealing primarily with points 3 and 2 b), although we will also discuss some of the aspects of points 1 and 2 a), in part II: "Current Implementations".

Problems such as security, payment and copyright of Internet material are on their way to be resolved. Moreover, the need to increase the power of the Internet's backbone and to provide greater bandwidth for new multimedia and real time applications will be soon overcome. Already, several telecommunication companies have established new infrastructures in order to provide higher speed access for Internet users, and Internet engineers are working on new protocols to help manage the existing bandwidth for a more efficient use.

1.3 Previous Works:

Researching, assessing and writing about the different effects of the Internet technologies on telelearning is a challenging task. Every day, new developments and upgrades in this field bring in new opportunities, risks and incentives to learners and instructors, which can considerably effect the educational environment. Likewise, the different scenarios of connections and the deployed sets of tools, produce different outcomes for each single case.

Publications about the Internet and its impact on the educational environment are many. Most of them, though, discuss the use of the medium from a pedagogic point of view, and examine the impact on the

students learning, as almost of the authors are instructors and individuals with an academic background. The only research that we could find which deals with several aspects pertaining to telelearning via the Internet was, the thesis of "Shin Yamazaki" from the university of Colorado in partial fulfillment of his Master of Science in Interdisciplinary Telecommunications Program.

That paper was mainly focused on a comparison between the problems of the current distance education programs, and the potential benefits of using the Internet instead. Despite the description of some of the Internet tools, there was no illustration of how these tools could be deployed within a telelearning environment. Moreover, the author limited his study to the already existing technologies and Internet tools, while it was more appropriate when dealing with such a dynamic and continuously developing medium to investigate future possibilities for a more efficient delivery of the educational material via the Internet.

Other works, such as Robin Bernard et al.'s book, "The Educator's Guide to the Web", as well as many published papers most of which are being referred to in the bibliography, which either dealt with the use of the Internet within a traditional face-to-face classroom, or with using proprietary desktop conferencing packages. Even though the latter has some similar outcomes to the Internet-based telelearning, Internet-based telelearning has significant different outcomes than when desk-top conferencing software are used, as will be discussed in the coming chapters. Many articles also discussed the possibilities of using the Internet for distance education, however, analysis was limited to the very basic Internet tools such as e-mail applications and the Web.

1.4. Objectives of this Research:

Despite the challenges of the Internet's dynamic environment and the difficulty of encompassing all the effects and possibilities of this medium, we have investigated in this research the various aspects, the issues and the possibilities of using the Internet within a telelearning environment. A survey of a group of telelearning practitioners has supported this work and provided additional information about this emerging practice.

More specifically our goal in this research was:

"to investigate innovative methods of using the Internet for telelearning. This involves describing the way in which current educational institutions are using the Internet, examining the different Internet tools and investigating future developments in Internet technology that allow for real time audio/video plus low cost multicast capability. Several issues are discussed with some suggestions about possible solutions."

1.4 Methodology:

Our methodology was mainly based on the following elements:

1. on-line search and use of the World Wide Web resources,
2. participating at the Distance Education On-line Symposium (DEOS) mailing list, provided by The American Center for the Study of Distance Education (ACSDE), at The Pennsylvania State University,
3. making on-line interviews with some Internet technology and security experts and staff from virtual institutions.
4. using books and publications,
5. conducting a survey to the telelearning community, via the DEOS-L mailing list.

In view of the recency of our subject, most of the resources used in this research were WWW material. Moreover, inasmuch as the subject itself deals with the Internet and the WWW, information about case studies and most recently developed Internet tools and technologies were mostly available on the Web.

5. Organization of the Research paper:

The main sections of this research comprise the following parts and chapters:

- Part I: Internet tools, which involves:
 - Chapter 1: Asynchronous Internet communication tools and
 - Chapter 2: Synchronous Internet communication tools.
- Part II: Current implementations, comprising
 - Chapter 3: Internet Distance Education Applications: Classification and Case Examples, a paper which was published in *Education as a Distance journal*, issue of July 1996, Volume 10, number 7,
 - Chapter 4: The survey: Results and Analysis, and
 - Chapter 5: Yahoo! Internet Life. survey analysis.
- Part III: Economics of Telelearning Via The Internet, including:
 - Chapter 6: Student Related Costs, and
 - Chapter 7: Institution Related Costs.
- Part IV: Issues with Telelearning Via The Internet, which comprises:
 - Chapter 8: Internet Security, and
 - Chapter 9: Policy Issues.

6. Usefulness of this research:

The outcomes of this research would be mostly useful for:

- Administrators of academic institutions, including schools, universities, businesses and training organizations, who are planning to make the Internet an integral part of their educational programs. This research can be useful for them while designing their business strategy, where evaluating the different aspects of the medium and investigating the different possibilities of the tools is central before proceeding.
- Organizations with the objective of setting virtual institutions, without any previous experience in the educational field and the effectiveness of certain applications in conveying the intended messages.
- Independent instructors who want to design and teach an on-line course via the Internet, and to integrate its different tools for an enhanced, higher quality course delivery.
- Traditional and non traditional students who want to take on-line degrees and courses.

PART I:

INTERNET TOOLS

Chapter 1: Asynchronous Internet Communication Tools

Chapter 2: Synchronous Internet Communication Tools

INTRODUCTION:

This section provides a description of the different Internet tools, those which have been already applied, and those which will be used in the near future to support an Internet-based telelearning environment.

Based on the type of communication they provide, the Internet tools fall under two main categories:

- **Asynchronous tools:** which are programs and applications used for on-line communication with time delay, such as e-mail, and are discussed in chapter 1.
- **Synchronous tools:** which permit real time interaction, such as the video-conferencing software CUSeeMe. Internet real time applications described in chapter 2.

Each chapter provides a description of the tool or the technology and its different features, followed by its advantages and its limitations. Finally, some case examples are supplemented, about how it is being implemented for on-line lectures, or how it can be used in the near future.

Unlike the most recent tools and technologies such as CUSeeMe and the MBONE, popular tools such as e-mail applications, have not been described in as much detail. Instead, emphasis was on their advantages and limitations and on the recent developments and additions which can improve an on-line interactive environments.

Chapter 1:

ASYNCHRONOUS INTERNET COMMUNICATION TOOLS

1.1 Introduction:

In an asynchronous communication, there is a time delay between a statement and a response. The time delay can vary between minutes up to days or even months. Using this type of tools within an Internet-based telelearning setting is very important for its users as it provides them, besides other benefits, with flexibility and convenience. An asynchronous communication can be interactive, such as in the case of e-mail and Web conferencing, where users can exchange messages and hold discussions.

In this chapter, we will be discussing the two principal asynchronous tools of the Internet. These are the electronic mail(or e-mail), and the World Wide Web(or the WWW). After giving a brief definition of each tool, we will be examining some of their common applications, which can be very meaningful for telelearners via the Internet. The considered applications are: mailing lists, listservs, newsgroups and multimedia e-mail for e-mail, and Web conferencing, JAVA, VRML and other Plug-Ins for the World Wide Web.

1.2 Electronic mail:

Electronic mail is an asynchronous method of telecommunication, which allows users to post private, individual or group messages on-line. E-mail is the most popular Internet application. Many educational institutions having access to the Internet, are heavily using this tool to support their regular courses for communication and information exchange.

The reasons behind e-mail popularity are:

- It is easy to use and requires a simple Internet connection.
- Messages are quickly delivered, which improves student-instructor communication and support, facilitates receipt of course material and speeds up feedback.
- E-mail has many interesting features which allow for group collaboration, such as message forwarding.
- It is not time or place dependent and messages can be accessed at any time. Accordingly, interaction between class members becomes more flexible, as it increases the instructor's availability and allows class discussions to extend beyond the regular class time. The asynchronous feature of the e-mail, provides students with more time to think about an appropriate answer, and to phrase their responses more carefully than would be possible in a situation where an immediate answer is required. Such extended and better organized discussions can be very helpful for a more efficient assimilation of the material.

- It is a cheap method of contacting people in different areas around the world. This brings opportunities to class members to reach multinational experts and students, and to move from local to global discussions.
- Different file types can be attached to a message providing greater support to text-based messages.
- New browsers added HTML to e-mail. This means that a sender can include links to several Web links in the message. This feature is very useful in a telelearning environment to support message. By way of illustration, instructors can use it to support their answers to students' questions by inserting links to Web documents.

E-mail, also, has several limitations which prevent it from being used as a single tool for telelearning. In many cases, these limitations can outweigh the economic advantages of this tool, especially if it is to be used as a basic tool for on-line lectures.

Despite the advantages of the option of sending different file types as attachments to messages, the wide variety of encoding methods used can cause several problems to the receiver as well as to the sender. Before sending an e-mail file attachment, certain factors should be taken into consideration.

Since e-mail attached files are ASCII character based, they cannot be sent in their original binary format. The attached files need to be converted into ASCII format using some encoding program before sending. There are two common methods for encoding: MIME and UUENCODE. Most Internet e-mail software (like MS Exchange, Netscape Mail, or Eudora) already integrated one of the encoding methods into its file attachment functionality. These programs enable the user to set the attached file encoding type. Hence, as the receiver assigns the attached file, the latter is automatically converted.

There are also several other encoding schemes. If a user receives an e-mail attachment encoded using a method different than his or hers, the attached file can't be automatically converted because of that difference, and the encoded attached file(in ASCII character set) remains inside the received e-mail. Therefore, the receiver needs to manually convert (decode) the file back to its original format.

In order to prevent such problems within a telelearning environment, on-line class members can agree on a standard for the course. This can be sometimes difficult, since every student would have to have an application which supports the agreed upon encoding system, which limits the flexibility of this tool. As stated earlier, e-mail can be used to send several types of files, including graphics and multimedia.

Animation, sound, graphical and picture files are usually very large. The larger the file, the longer it will take students to download their e-mail with multimedia attachments. Moreover, in order to retrieve then execute such files students require a lot of disk space. The sender, either the instructor or a student, forwarding large files has to inform the receiver(s) before sending the message. Receivers should be given time to respond to the announcement and to be able to revert to these files from being sent to them. The receivers must be also able to control what ever they receive. In case there are so many such files, or very large ones, their system can be jammed. Carrying on this type of communication therefore can be very time consuming, and can exhaust the network resources.

There are several other methods to expand basic e-mail functions and to organize various group discussions in an on-line class. These include: mailing lists or listservs and newsgroups.

1.2.1 Mailing lists-Listsers:

Mailing lists allow the redistribution of an e-mail to a list of subscribed addresses. They usually have a subject about which participants can make announcements and discussions. Mailing lists, therefore, can provide a useful way for teachers interested in specific topics to communicate with their peers or students from other institutions who share the same interests.

There are different types of mailing lists. A “moderated” mailing list is one where only the list owner or the moderator receives all the messages and then decides whether to forward them to the subscribers or not. Moderate mailing lists perfectly suit on-line class discussions, where a mailing list for the class can be set with the instructor as the moderator and students as the list member. “One way” mailing lists, which do not expect replies from receivers, can be also used jointly with moderated lists to post announcements or news to the students. “Public” or “open” mailing lists provide an opportunity for students to get in touch with multinational experts in the field they are interested in, and to contact other students from different schools and countries.

Mailing lists provide users with the same features as the basic e-mail such as different file attachments and mail forwarding. One popular program which is used to manage mailing lists is called “listserv” which became synonymous to mailing lists.

Some of the limitations of mailing lists include the following:

- It is hard to follow the thread of a discussion, unless participants specify the name of the subject heading in their replies.

- Mailing lists need to be continuously managed. That is e-mail should be regularly read and useless messages should be deleted, otherwise the users' mailbox can be overwhelmed. This can be very time consuming, especially if the mailing list is very large.
- Because of the overwhelming and uncontrolled e-mail, it is difficult for a user to subscribe to several mailing lists at the same time. This, as a result, limits the opportunities for students interested in several subjects to take part in multiple discussions.

1.2.2 Newsgroups:

Newsgroups, also referred to as Usenet news, is another e-mail application which allows several people to discuss and exchange messages and files. Each newsgroup has a specific topic. Unlike mailing lists, users do not have to manage their incoming mail. With newsgroups, a newsreader should be used. The software's main function is to manage the incoming messages, and to display them in threads. Having a thread of messages means that a message and all its replies are linked together, making it easy for a reader to follow an entire discussion. This represents a very important advantage over mailing lists and regular e-mail.

Users can access newsgroups by using the telnet protocol and a newsreader software working in a server. Newsreader software are freeware or shareware, which are freely distributed but require payment for later usage.

Even though Usenet news is very time consuming when feeding news, this method can prevent traffic congestion, since it can be accessed from many sites each having its own copy of news.

The reasons why instructors and students use Usenet news are very similar to those for using mailing lists. Moreover, Usenet news can be very effective in case students want to participate in several newsgroups with different subjects, while being able to manage the overwhelming messages.

Newsgroups are usually focused about specific topics. It is, therefore, easier to find newsgroups of interest to the class than using public mailing lists. As mentioned above, the threads option makes it easier for students to follow the flow of a discussion and to see what others contributed to a specific topic; an important feature for beyond the lecture time discussions which have been carried on for very long time periods.

One other important advantage of newsgroups over mailing lists is that messages are available on-line from a few days to a few weeks. Mailing list messages, on the other hand, are not stored anywhere on-line. This feature helps students to verify whether the questions they want to ask have been recently asked and answered or not. Also, if students want to join a public newsgroup, the instructor can tell whether that it is appropriate for their interests or not by reviewing the discussions of the chosen newsgroup.

One important thing to note though is the lack of control over the posted material. Indecent material can not be restricted when using open newsgroups. If an instructor is planning to provide newsgroup access to students, he/she can investigate the software programs designed to allow parents and educators to limit student's Internet access. In many cases, instructors might want to screen out certain messages during a discussion. With a "kill file", the instructor can set the newsreader software to ignore articles with specific information.

1.2.3 Multimedia for E-mail:

Adding multimedia to e-mail is of great benefit to e-mail users, including academic users. A multimedia e-mail message can include still images, audio and video clips. In an educational environment, adding fonts, color characters, graphics and audio and video clips adds value to the received message, especially when used for courses where multimedia material is fundamental, like in arts and biology classes. The asynchronous feature of e-mail makes multimedia file exchanges more efficient than when performed using real time applications such as CUSeeMe and Internet Phone, where packets of information are required to be received within a limited time. With multimedia e-mail packets are transmitted at an unhurried pace. Unlike with real time applications, if the receiver's network connection slows down or data packets arrive out of order, they are reassembled in sequence with no loss of continuity. This advantage, coupled with the current bandwidth and networking problems, can imply a faster adoption of this tool in the telelearning environment than real time applications such as CUSeeMe.

With the ongoing developments to upgrade the Internet, such as by implementing new protocols and technologies to better manage bandwidth and to allow for multimedia transmissions, multimedia e-mail can be a very efficient tool for supporting text based messages, in particular between students and instructors.

MIME

Multipurpose Internet Multimedia Extensions(MIME) allows Internet users with different computer systems to integrate multimedia to e-mail, including graphics, sound, Postscript files, pointers to FTPable

files and motion video. It also permits them to interchange text in languages with different character sets. Currently not all e-mail clients can handle MIME, but an increasing number of them do. One powerful feature of MIME is its ability to survive the different e-mail protocols, which facilitates communication between users with different protocols.

Videomail:

Videomail is another shareware program which adds multimedia to e-mail, and which can significantly enhance electronic mail messages. It allows users to send a Quick Time video or audio of the sender. The tool digitizes video or audio, then sends it to the receiver with a Quick Time encoded attachment. Other file types can be also attached to the audio-video messages.

Fig 1.1 : Videomail screen shot

Source : <http://www.shout.net/~dtrinka/home.html>

Possibilities and limitations of multimedia e-mail:

Introducing multimedia and audio-video clips is of great value for communication in an educational setting. If used properly, such specifications allow instructors to support their messages with the required multimedia material, graphics, sound or/and video clips, which gives more value to the message, and facilitates students' assimilation of the lecture material.

Because of its several advantages, its low cost, as well as the recent upgrades and developments over the Internet, multimedia e-mail is likely to be available and widely used before Internet real time applications, such as CUSeeMe. Unlike real time tools, the asynchronous nature and time independence of multimedia mail means that sending or receiving a multimedia message is not required to be there within a specified time. With multimedia mail, information can travel at a more flexible pace. Therefore, if the network connection slows down, packets which might have arrived out of order are reassembled in sequence with no loss of continuity.

One other important point, which was noted by Savetz et al. in their book "MBONE Multicasting Tomorrow's Internet", is that with the increased development of Internet tools, Internet Service Providers

are very likely to set their charges based on the amount and the speed of delivery of information sent rather than on the connection time. This means that real time applications using large amounts of bandwidth, and requiring fast distribution might be very expensive. This would imply a very costly option for students, instructors as well as for academic institutions with limited and shrinking budgets. On the other hand, multimedia e-mail can be the best cost effective alternative, since although it might use the same amount of bandwidth, precise data timing is not very critical.

Some of the main issues of multimedia e-mail include the following:

- Like any other e-mail application, security is a major issue for multimedia e-mail. In order to secure their messages, users will have to use the Privacy Enhanced E-mail(PEM) and its derivatives.(Security issues will be covered in more details in chapter 7).
- Another issue is that files containing audio, video and graphics use a lot of bandwidth and are time consuming when downloaded. Moreover, receiving large multimedia files can easily congest the users network leading to long delay and costly network problems.
- If multimedia e-mail is to be used as a basic means of on-line interaction, the asynchronous nature of multimedia e-mail combined with the slow downloads and the possible congestion problems can be very frustrating for telelearners, which could likely effect their participation rate and their productivity. Multimedia e-mail therefore is most appropriate to be used to support tool in conjunction with other conferencing tools such as real time text based conferencing, when the instructor wants to save on the downloading time during the lecture time.

1.3 The World Wide Web:

Often referred to simply as the Web, the World Wide Web is a wide area hypermedia information service which allows computer users to easily navigate and access the large information databases of the Internet. One powerful aspect of the Web is its use of hypertext links, which allow users to jump from one file to another. Another interesting feature is its ability to support multimedia as well as many other file types, which can be viewed with external viewer programs.

The Web was developed in 1990 at the European Center for Nuclear Research (CERN), as a way for scientists to share documents. By 1995, it was the fastest-growing Internet service and the most popular and effective means of information interchange on the Internet. At present, the Web is being used mainly as an information resource, but numerous additional applications are possible.

The WWW is a client-server hypertext based information retrieval tool. A Web server is a program running on a computer responsible of sending documents to other computers when asked to. When a user asks for a document, the client, also called the browser, which is a program interfacing with the user, requests the document from the server. The server responds by sending the text, and any other media within that text to user screen.

In order to be able to send and receive hypermedia files, servers and clients communicate using the HyperText Transmission Protocol (HTTP). Files are written using the HyperText Markup Language(HTML), which is a simple markup language for logical document layout. Logical document layout means defining elements as headings, texts, paragraph returns, lists, bullets etc. The HTML file contains links to other information sources called the Uniform Resource Locator (URL).

Many commercial Web browsers are available today, and many are based on the NCSA Mosaic design, which is one of the original browsers. Most of them include new reading capabilities, menu maintenance tools for bookmarks and extensive sound card support. New versions are more efficient and more powerful, as they have lower memory requirements and contain many new extensions. These include virtual reality and 3D objects manipulation, audio and video, and languages such as Java and ActiveX, which run independently from the operating system.

The Web today is a very basic element for educational environments with their different levels. As mentioned above, it grants several educational opportunities for students by providing them with access to a wide range of universal knowledge resources. The possibility of integrating and interacting with different media files can actively stimulate them to be more active in contributing than if they were in a traditional classroom passively receiving material. Using the Web as a basic learning tool allows student to use advanced tools and software. This would help them develop certain computer skills that can increase their motivation in the short term, and could be very useful for their careers in the long term.

1.3.1 Advantages of the Web:

The main advantage of the Web is that information is dynamic. This is a very useful feature for on-line instructors, since it allows them to change and update their material whenever there is a need for it. As a result, students are always kept up to date with the most recent changes and news about the lecture material.

The WWW hypertext format is also a very important feature. The use of hyperlinks allows students to browse, jump between links, have quick access to relevant material and to perform searches easily. Moreover, writing HTML documents is easy, and requires very basic computer skills. With the development of new editor tools which assist in designing Web sites, users can create Web pages without having to insert the HTML codes manually. By attempting to emulate a WYSIWYG (What I See Is What You Get) environments for HTML authoring, Web page design has become fast and very easy. Such tools are of great benefit to instructors with limited time, who want to provide their students with comprehensive web pages with relevant references to course material. A user can even easily translate a regular file into HTML format using tools called filters. These are very helpful, especially in case of long documents such as hypertext books. Hypertext books allow students to jump between chapters and references without the need for downloading and reading the whole book.

An extensive list of editors is available at:

http://www.yahoo.com/computers_and_Internet/Internet/World_Wide_Web/HTML_editors

Another list of filters is available at: <http://www.w3.org/hypertext/WWW/Tools/filters.html>.

One other important feature about the Web is its ability to run multimedia applications, and to integrate audio, animated video, graphics, pictures and text. This represents considerable support for teachers during on-line lectures as it helps them in creating a dynamic learning environment. Downloading such documents, however, is very time consuming, and is not always an easy task due to the limited network resources, as will be explained in section 1.3.2 "Problems and limitations of the Web".

While designing a course's Web page, or any other hierarchical document for on-line telelearners, many elements should be taken into consideration. Convolved and complex document structures can be confusing for students and other users, and can disorient them. Hierarchical design is not always the best way to get to the required material, and direct access might be, in some cases, easier and less time consuming.

An instructor's Web page usually provides much excitement and learning for students as well, as for other instructors or other users who can access the Web page. It is very important, therefore, to consider the readers' needs and convenience. Some of the design tips which should be followed include:

- Making the page design easy for navigation by providing the user with the appropriate links.

- Limit the number of graphics, especially when most of the users have slow connections. If the designer needs to use graphics, better use thumbnails that users can select if they want to see photos and graphics.
- Design the pages in a way which allows users with different browsers to get the necessary information. Some students or other users might not have access to browsers which support some features.
- Use important key words prominently in the home page so that search engines direct users to that page.

1.3.2 Problems and limitations of the Web:

One main problem with the Web is that for users to fully benefit from its potential, they need powerful computers. If the student does not have access to a powerful PC or Macintosh, downloading multimedia files can be very slow. This issue, however, will be hopefully solved in the near future, as higher speed access becomes common. Further, most of the computer systems available today in the market are powerful enough to allow the use of the different powerful features of the Web. These computer systems usually come with the appropriate operating systems such as Windows or Mac OS7, or higher, which enables them to easily run the Web's clients and browsers.

One temporary solution to save the downloading time, is to turn off the images, so that only text is received. Sometimes however, images, sound and animation are very important to understand a document. If users want to play a movie or a sound clip, they need sound-and movie players. The client they use must support those extra applications. Netscape for instance, has many extra features, but they are not standardized yet, and therefore not compatible with the browsers. A user can still read the Web pages using other browsers, but many of the important features can be lost. The instructor, therefore should design the course's Web page so that all students get almost the same information, otherwise asking all students to use the same browser might not be always possible.

In addition to the technical problems, there are also some pedagogical problems which need to be addressed. in order to ensure the effectiveness of the Web as an educational tool, and to increase the reliability of the published material.

First, there is currently no censorship, which means that students can easily access some inappropriate material. This problem which is being currently addressed by major telecommunication commissions.

Also, while carrying out searches, students can find thousands of links related to their subject. The large amount of information can be very overwhelming for students when trying to choose the most appropriate document. Fortunately, many search engines today are being developed that tend to narrow down searches and to provide users with the best possible match to their queries. A case in point, is Alta Vista's Live Topics. By asking the user to select additional words and eliminating unrelated topics, the query is refined which produces more relevant results.

Another problem is that because of the easiness of modifying Web material, relocation of addresses and sites is very common. As a result a user cannot guarantee that today's active addresses will be available the following week. This can be impeding and problematic for on-line instruction since important references to course material or to students' researches can be easily lost.

Finally, because of the low barriers to publish over the net, users including instructors and students can find difficulties in assessing the quality of the published material. In fact, anyone can publish a document over the Web. The issue of evaluating Web material will be discussed in more details in chapter 9: "Policy issues", along with some suggested solutions.

1.3.3 Case examples of the use of the Web within a telelearning setting:

Many school systems, both K-12 and post secondary, are aggressively moving today towards an increased deployment of the Web. In Florida for instance, a statewide network called the Florida Information Resource Network(FIRN) has already been established in order to link educators throughout the state. The network is being upgraded so that the maximum number of Internet users can take full advantage of the World Wide Web. Within the next few months, the Web will be available to school systems throughout the state. A further step is to make the Web available to individual classrooms by upgrading the wiring and getting appropriate hardware and software.

Another exemplar for using the WWW for telelearning is CyberEd. CyberEd is a full credit university, offering on-line courses on the Web, through the University of Massachusetts Dartmouth Division of Continuing Education. Its main objective is "to create a distance learning environment that rivals the traditional classroom environment in the quality and the content of the learning experience (it) can provide" and "to provide plenty of opportunities for meaningful student-to-faculty and student-to-student interaction". Currently 21 courses are offered, and just five are non credit courses. Class sizes are limited to a range of 10 to 25 students, in order to allow the instructor to effectively interact with all class members.

In addition to traditional resources such as textbooks, students also heavily use the extensive on-line Web resources. Class material and assignments are posted on-line in a Web page, with hyperlinks to extra relevant material. Assignments and projects including multimedia files and graphics are submitted on-line via e-mail, and can be later posted on-line for others to consult. Class members interaction is mainly asynchronous, providing a flexible environment for students with different schedules and needs. Also, CyberEd courses make use of forms for class interaction and testing.

Currently, hundreds of students are taking courses with CyberEd. Its flexible environment, eliminating time and place restrictions and allowing for easy access and reach to valuable information are the main motives which are encouraging more and more students to join this type of environments.

CyberEd home page is available at : <http://www.umassd.edu/cybered/whatis.html>

1.3.3 Web conferencing

The various powerful singularities and ceaseless upgrades of the Web's environment, coupled with the increased need for real time interaction in a user friendly environment, have encouraged developers to make use of this medium to hold conferences, such as on-line social chats or on-line lectures.

Conferencing has been available on the Internet for years in the form of Usenet newsgroups, that we examined earlier under section 1.2.2. When support to forms input was added to HTML, conferencing over the Web became possible. Web conferencing is a Web-based form of group discussions that uses Web browsers and servers to provide users with an interactive but asynchronous medium.

Figure 1.2 portrays a common window in Web-conferencing software, consisting of: a form where messages are added to threads, options of reading previous messages within the same thread and other threads, a help and a main page button.

Response by Mystery Guest

☒ Continue in the current thread (This is great!)

☐ Begin a new thread named

Summary:

post clear

main screen log out new login help

Fig 1.2 : Sample of a Web conferencing form.

Source: <http://www.emaze.com/cgi-bin/cgiwrap/emaze/demo>

Within a telelearning environment, applications of Web conferencing are very effective in creating an interactive setting. One interesting application of this tool is holding on-line class discussions, and supporting messages with hypertext links to Web resources. As a result, students can better understand the lecture material, and class time can be used more efficiently, as discussions are held for a longer time. Moreover, links to previously discussed topics can significantly reduce the need for lengthy quotes from previous messages.

One of the main reasons for using Web conferencing software over the Internet is that the Web offers a big number of client and server software, which support a wide variety of hardware. Proprietary systems are very unlikely to match the Web's universality. The main strength of the Web is that it provides a common user interface for several utilities such as FTP(File Transfer Protocol), Gopher and WAIS(Wide Area Information Servers). Extending the Web's service to conferencing allows users to access the Internet's invaluable resources, and to interact with multiple parties, without leaving the familiar environment of the Web. Furthermore, a conferencing system on the Web can be designed to scale well; inasmuch as the data can be distributed across any number of servers, there are no inherent limits to growth.

A Web conferencing tool is usually a normal http server with added capabilities. This server keeps track of all users located on pages, serves for a public chat area and relays the data in the public conferences to the participants. Private conversations and public conferences are handled differently to minimize the load on the server. For private conversations, the server simply provides the two parties with each other's address, the connection is made directly between the two. For multi-party conferences, the user sends the message to the server, which relays it to other participants. Messages are received with data identifying the sender and

the discussion it was sent to, since some Web conferencing software allow the user to be involved in several conferences at the same time.

There are several features and powerful characteristics of Web conferencing which make it far superior to mailing lists and listservs. These features can be summarized under the following points:

1. They allow for separate conferences related to several subject areas. For an on-line course, this feature would be useful for groupwork, where students can be involved in more than one discussion group each with a different subject area.
2. They provide users with threaded discussions within a conference. Threaded discussions is a good way for organizing static information. They sometimes take the form of a tree structure, where each topic is the main root for branching responses. This structure, however, can be inconvenient for conversations. By making discussions fragmented and dissipated, users can easily get lost, and can hardly figure out where to attach a response. Web conferencing software using the star structure are able to easily overcome this problem. Using the star structure, each topic has a simple chain of consecutive responses attached to it. Hence, users can easily understand this form, which closely resembles real life conversations. WebNotes and HotWired's threads are examples of Web based chat areas which use the star structure.

For on-line students, this feature allows them to keep track of the discussions even when they are not on-line.

3. They provide users with a list of topics in a conference, as well as the amount of activity in each topic. This includes, for instance, the number of responses and the date of the last response. Messages can be also sorted both by topic, start dates and by last response dates.
4. They respect the integrity of topics by allowing users to go back to the start of the topic and to follow it all the way through to the most recent response. This permits students to refresh their information and to better keep track of the conversation, especially if the discussion was held during lecture time, and that the instructor had stated important points and comments. In order to avoid clutter, the instructor can filter out discussions and keep only the relevant material.
5. They provide users with the ability to perform searches by date, author and keywords on both topic titles and message texts.

They furnish the options of holding private and public conferences. Some Web conferencing software require a conference host or moderator, who is usually the instructor in case of on-line classes. The moderator has flexible control over the discussion, and has the authority to limit access to the desired participants, to give particular participants read and write permission, while others read only.

A comprehensive list of Web-conferencing tools and resources available at:

<http://freenet.msp.mn.us/~drwool/webconf.html#freeware>

as well as at: http://www.yahoo.com/Computers_and_Internet/Internet/World_Wide_Web/Chat/

1.3.4 Issues and Challenges:

There are more than 60 Web conferencing systems today, compared with just two at the beginning of 1995. Although Web conferencing is always improving, it is still easier and more comfortable for users, (especially heavy users of interactive tools such on-line telelearners) to telnet to a simple text based real time conferencing tool such as MUDs and MOOs (discussed in chapter 2). The problem, however, lies in the Web architecture itself and not in that of the Web conferencing systems.

The main issues with Web conferencing are listed under the following points:

1. **Software performance:** the Web is very slow for highly interactive applications in view of the overhead involved when navigating large amounts of material. Delays when choosing links can significantly hamper smooth communication, especially when participants are trying to interact in a nearly synchronous way, during a group or class discussion for instance.
2. **User interface:**
 - Navigating a Web conference is performed using the embedded HTML links. The lack of keyboard navigation can further slow down browsing messages. Web software developers are currently working on solutions to this problem by incorporating HTML frames and Javascript.
 - Including HTML links in messages might interfere with the functioning of the conferencing software and might be disorienting for users. Extra formatting of the display should be applied in order to distinguish between message contents and structural elements of the Web conferencing software, which is a complex design issue.
 - With the existing Web conferencing software users have to always write messages into forms. Upgrading the tools to support uploading of existing files would save more time and make conversations faster.
 - Involving active hyperlinks in messages might disorient the conversations, as students might start wandering around the Web resources during discussions. It would be interesting to find ways of disactivating and/or limiting the activated hyperlinks during the discussion to a few specific applications.
3. **Lack of users' support:** Only a few of the Web conferencing software today have "wizards" which guide users through the installation and the interaction process, while many others do not. Therefore,

- upgrades to make these software more user-friendly are required in order to make them more convenient to users with little or no computer literacy, like the elementary and high school students.
4. **Multimedia files attachments:** Even though Web conferencing applications enable users to include multimedia files in messages, this is still problematic. Including a link to an already available image on a Web server is not a problem. The difficulty arises when adding a new image to the server. The user should be able to import the image from a drawing program, type a message and send it to its destination. This requires both: more sophisticated HTML document editors than the ones available today, and a coordination between the Web server, the Web client and the document editor. The new HTTP-NG, which is a revised version of HTTP, promises several improvements in performance and in coordination of server/client connections.
 5. **Security:** Most of the Web conferencing software available today, do not provide a protection of the delivered material. Before each message delivery, a window pops up warning the sender that the information can be viewed with other parties. Some of them, however, are using passwords in order to restrict access to the desired participants only. The security issue is common to any Internet application. Research in this field is continuous. Hopefully, soon most of the Web conferencing software will provide their users with a private and secure environment.
 6. **Multi-party conferencing:** Some of the existing Web conferencing software are not suitable for nearly real time multi-party conferencing. Microsoft NetMeeting, for instance, which comes with Microsoft Internet Explorer, works well for point to point real time audio-conferencing, while other participants can only join and contribute to the conference using text. This can be suitable for one to one student/teacher consultations, but would be difficult to use during the lecture time.
 7. **Bandwidth:** Bandwidth is a common issue for highly interactive applications. As long as users do not have high speed access, multimedia interactions be easily slowed down and impeded. Some browsers today, such as Netscape, are using a quicker Web client technology for downloading files by displaying each page as it is being received and aborting transmission if the user selects any link.

Fortunately, many of these problems, today, are on their way to being solved. The new HTTP version, called HTTP New Generation, or HTTP-NG, will be used in communication between browsers and servers. Under HTTP, the Web browser must establish a new connection with the server for every requested document, leading to time-consuming handshaking procedures. Under HTTP-NG, a browser can maintain an open session with the server while it requests multiple documents, which can make Interaction more synchronous. This change, however, will take a while until software changes to both browsers and servers are made. The independent platform Java applications are also promising many advances for Web

conferencing systems. One main advantage is that Java based Web conferencing systems can take full control of the screen layout, and can implement any type of key or mouse interactions. This would solve many of the user interface problems.

At this time, there is still no “best” Web conferencing software, especially with the wide variety of options and features which come with them. As a result, choosing the appropriate software for an on-line lecture mainly depends on the class needs and requirements.

1.3.5 Case example of a Web conferencing software:

The following is a description of a Web conferencing software, called “Dialogue” which is being used to deliver a Visual Basic on-line course via the Internet at the “Elgin community college” at Elgin, Illinois. This software is primarily used for class discussions and for asking questions about the class material. A Dialogue icon is available for students on the instructor’s Web page. By clicking on that icon, students can access Dialogue discussion area, see all related questions that have already been asked as well as the instructor’s replies. Students can ask follow-up or new questions. By having all the previously asked questions posted, students and the instructor save the time of repeating the same question and answers, and helps students receive timely answers.

One important feature of this software is flexibility. As an example, users have total control of the messages that are posted through Dialogue: with an administrative password, they can edit or delete any message, and they can rearrange messages into more logical discussion areas or categories. When viewing and responding to messages, a user has the option of highlighting or viewing only the most recent messages. Replies can be viewed by discussion category or as a whole set.

Based on the Dialogue users’ experience, this tool allowed a diverse group of students with different needs and life commitments to talk and interact together. With each lesson having its own discussion area, students can split into groups, and have their own discussion in a separate “room”, where they can brainstorm and work on their group projects on-line.

Dialogue is available at : <http://www.mcs.net/~pelczars/magic/dialogue.htm>

1.3.6 Future developments:

Several developments are taking over the Web in order to improve its use and its educational value and to make it more suitable for live interaction. The following section describes some of the main current

developments which are relevant for the telelearning community. These include: HTML upgrades, Hyper-G, JAVA and Plug-ins.

HTML upgrades:

HTML is continually evolving and upgrading in order to provide the Internet community with more powerful features. At the time of writing this paper, the most recent version is HTML3.0. This specification provides several effective features, such as: tables, using a markup style suitable for interpretation on wide range of output devices, including Braille and speech synthesizers, as well as many other options some of which are described in the following paragraphs.

HTML also helps catering for non graphical browsers. Text can be flowed around figures and the user can control when to break the flow to begin a new element. Including this option makes the WWW more convenient for many students with different browsers, and helps reducing the download time, as they might not need all kind of viewers and applications to view some documents.

Furthermore, HTML3.0 includes support for equations and formulae compatible with most word processing software, using a simple style of markup. This provides math students with more convenience when writing their documents and prevents the drawbacks of converting math equations to on-line images.

Additional features include a static banner area, present at all times while the student is skimming the Web. This area can include disclaimers, notes, warnings, class announcement, and customized navigation and search controls. Forms have been also, extended to include graphical selection menus, scribble on images, file upload and audio file.

All these features provide the instructor as well as the student with rich opportunities to improve on-line interaction while benefiting from the invaluable Web resources.

Hyper -G:

Hyper-G is an information system, developed at Graz university of technology, Austria, which was created as an alternative to the WWW to overcome problems of finding information while searching the Web. The WWW was actually designed for smaller amount of data, and as it is getting larger the searching problem increases. Hyper-G, as its developers describe it "is a WWW system for significant amounts of information". The main difference between the WWW and Hyper-G is its structuring facilities. In Hyper-G documents are grouped in clusters. These after can be grouped in several collections which can be also elements of other collections. The advantages of such hierarchy are very significant. First, navigation and

data administration is much easier. Also, automatic CD-ROM production becomes possible, and finally, much link editing disappears.

Hyper-G is fully compatible with current Internet technology and includes seamless access to popular Internet server technologies such as the Web and Gopher. It provides for hyperlink consistency to and from multimedia documents, full text retrieval, and client gateways to Gopher and the WWW browsers, such as Netscape and Mosaic. It also supports real multimedia tools for structuring, maintaining and serving heterogeneous multimedia data including text, images, digital audio and video, PostScript and 3D scenes.

The main advantages of Hyper-G over the WWW as summarized by Maurer, one of Hyper-G developers are:

- Hyper-G's new hierarchical system, significantly eases data administration and provides better support for users.
- It is capable of handling a variety of data types including animation, 3D, VRML;
- It has multilingual support;
- It provides a powerful hierarchical scheme of access permissions;
- It enables a user to add private links to documents they don't own;

Java:

Java is a full featured object oriented programming language similar to C++, which lets developers create small applications called applets, that run on any kind of computer. Its main advantage is its platform independence, which allows users to execute programs on the server. Java's architecture was designed to allow for efficient multiple platform operations on the Web or internal network, while minimizing the maintenance time and the development costs. Java applications, or applets, reside on the network in centralized servers. Whenever it is needed, the applet is delivered to the user's system, and starts running immediately.

In view of the user friendly environment the Java applets provide, such as animation and 3D manipulation, Java-based Web conferencing systems are becoming more popular. Using this tool in telelearning will provide users with a quicker, easier and more dynamic learning environment, which consequently improves their assimilation of the material, and allows lower school levels to apply high quality telelearning.

Plug-Ins:

Plug-Ins are a special kind of helper applications which can be used to extend and enhance the Web browser capabilities. Their main advantage is that they don't need to be configured but they are simply

installed in the browser. Plug-ins can be used to display different file types, and many have been developed to allow multimedia files to be downloaded from the Web and displayed on the Web browser window. Two of the main interesting plug-ins are: Adobe Acrobat and VRML.

Adobe Acrobat:

Adobe acrobat is a network communication software package which enables users to exchange and view fully formatted documents with advanced features, like text with different typefaces, multimedia, graphics and photographs, regardless of the platform, the operating system or the application used to create the originals. Recipients later can navigate, annotate, print or store the received document.

Preserving the original feel of documents is very important in an on-line educational environment. Using this software, instructors can convert electronic files created using different applications into the Adobe Portable Document Format (PDF), and publish them on their Web site for students' use. Thus, instructors can be assured that their files will be seen exactly as they want them to be seen. As a result, the quality of the delivered material is improved and the delivery time and money is saved.

The Acrobat Reader home page is available at:

<http://www.adobe.com/prodindex/acrobat/main.htm>

Acrobat has several features, which provide students with convenient options to navigate and manipulate data in the document. Some of these features:

- The exchanged files are smaller than the regular files. Hence, the downloading time is shorter, and lecture time is used more efficiently, when files are sent during a class session.
- The ability to change, select, copy and paste text parts of the document into other applications. Students therefore can capture and use information for their own personal use, such as other reports and assignments.
- The ability to annotate a document, customize it with a personal label and to merge notes from multiple sources into a single Adobe Portable Document Format (PDF) file for further review, or to summarize all the other students and instructor's annotations in a single complete file.
- The ability of making searches using keywords, throughout the whole document. This enables students to perform quicker searches, even in illustrations, charts and tables of documents indexed with Acrobat Catalog.
- The links and the bookmarks feature, which allow the user to move between files.
- The ability to zoom which allows users to magnify the page, and therefore better view the page in more details, especially in courses where photos and images are very important such as biology and photography courses.

- The ability to password-protect PDF files, to enable or disable actions such as: printing, changing the document, adding and changing notes, and selecting text and graphics. This is a very useful feature for instructors especially in case they send copyrighted materials, or when certain documents should not be changed such as medical images.
- The possibility of faxing Adobe Acrobat files, and to print them in color or black and white at any resolution.

VRML:

The Virtual Reality Modeling Language (VRML) is a programming language for describing multi-participant interactive environments via the Internet, hyperlinked with the WWW. Such environments allow users to rotate 3D graphics, which provide them with a better simulation of objects. VRML has been already used in several courses, such as medical and engineering courses. Integrating VRML in an on-line lecture provides students with a better grasp and comprehension of the displayed objects than the 2D graphics, as it better simulates reality. Some problems still remain to be resolved, though, such as the slowness of downloading 3D files, and the high CPU requirements of 3D displays.

Plug-Ins are constantly bringing in new powerful features to Web browsers. This is for instance, through the display of full motion video and audio clips using Quick Time, the implementation of the new time saving streaming technology, which allows multimedia files to be presented in real time as they are downloaded. Two of the popular software which use this technology are RealAudio and VDOLive. By integrating such tools into curricular projects and on-line classroom activities, any Internet-based telelearning setting can be significantly enhanced, and provides on-line students with a high quality learning environment.

Chapter 2:

SYNCHRONOUS CONFERENCING TOOLS

2.1 Introduction:

In a synchronous communication interaction takes place in real time. That is at the same time a message in any format, text, audio or video is sent, other participants receive the message and can reply to it. Real time conferencing over the Internet can be performed using various sets of tools, and can take different formats. In this chapter, we will be examining different types of the Internet real time conferencing tools, which use one or a combination of the three principal communication formats: text, audio and video.

2.2 Text Based Real Time Conferencing Tools:

The following section describes the three main real time text based conferencing tools over the Internet, which are: the Internet Relay Chat(IRC), the Multi-User Dimensions(MUDs) and the MUD Object Oriented(MOO). Based on these tools, several customized environments have been created. An extensive list of these environments is available at: <http://www.itp.berkeley.edu/~thorne/MOO.html>

The three first paragraphs describe each tool, as well as some applications to the telelearning environment. This is followed by a common section where advantages and limitations of text based conferencing tools are examined.

2.2.1 Internet Relay Chat:

The IRC is a worldwide on-line conferencing system, which allows real time electronic conversations between multiple users. The most interesting feature of the IRC are channels. Because it's a networked service, the IRC can have thousands of people talking at the same time. In order to avoid confusion, users can split up into the different channels. Each channel can be thought of as a room devoted to a particular topic or a group of people. Channels are very suitable for virtual classrooms or group discussions, where each group of students of a particular class can have their discussions separately. Participants in different channels can move from one channel to another, page and send mail to other people in other channels. In order to be connected to an IRC server to join an IRC discussion, a user runs a client program called irc. Each IRC server is linked to other servers in a large Web of data exchanges. The servers manage the complexity of tracking users, channels and messages. Once connection is established, the server is responsible of relaying all the commands and the messages to the network and vice versa.

One other main feature is that sessions of the IRC can be recorded for further references. this a very useful feature for on-line class discussions and lectures, since students can access the class archive later to review the on-line session contents.

Because of the universal access to the IRC and the big number of users, risks of abusive and inappropriate behavior are very high. In order to prevent this, users who create channels become channel operators. In addition to owning and running a channel, a Channel Operator (Chan-OP) has complete control over the channel, including making the channel private, limiting access, and making the necessary restrictions to avoid any offensive behaviors which might disturb discussions. Users can also get assistance from the IRC operators. Their primary responsibility is to maintain servers and to eliminate problems with IRC connections in general.

Within a telelearning environment, IRCs represent a very efficiently tool to support the on-line course delivery. After browsing the class material, students and their instructor can meet at a regular basis on an IRC channel to hold class discussions and ask questions about the materials they have already studied. The instructor can act as the Chan-OP by monitoring and controlling the discussions flow. IRC channels can be also used for holding smaller group discussions within a class session, and to work on group projects.

2.2.2 MUD: Multi user Dimensions, Multi user Domains, Multi user Dialogue or Multi User Dungeons:

MUDs are text based multi-participant virtual environments, accessible via the Internet which allow users from different places to interact in real time. These environments evolved out of multi-player adventure style game in the early 80's. Later, they began to evolve into more social and educational areas for discussions, instruction, information exchange, and lead to the creation of elaborate and networked environments. There are many types of MUDs available on the Internet. They vary in many details, such as their embedded programming language, and their storage methods for the objects they manipulate, as well as in their theme and interests. All of them, however, have the capacity to allow multi-party real time communication.

These virtual environments usually comprise thousands of interlocked descriptions of various settings and rooms. The rooms can be linked to other rooms forming a house, an educational institutions such as campuses and colleges, or any other organization, and from there to a virtual town, city, forest or whatever the writer's imagination desires. These environments proved to be very suitable for establishing a telelearning environment, and are being heavily used for this purpose. Several virtual institutions are a simulation of the "tangible" university or college building, while others are completely virtual areas, which have been constructed out of the designers imagination. A virtual campus(or any other academic institution), usually comprises an information desk to answer students' inquiries about subscription and other information, an administration office for dealing with subscription and all other administrative issues,

and virtual classrooms, where students meet with their instructors and hold class discussions. Instructors also have virtual offices, where they can “meet” with their students, and answer their questions. A student lounge is also designed, where students can socialize and chat about different subjects, in addition to a wide variation of other extensions.

Technical aspects:

The original idea of the MUD has evolved over the years into the client/server architecture. The main features of a MUD server are:

- To manipulate the database of objects in the virtual world, the current players’ names, descriptions and state (active, inactive), rooms, rules and other miscellaneous features of the MUD.
- To allow the extension of the set of objects, and
- To accept network connections from clients.

The clients’ software are usually written in the C language. Telnet is one such client programs that allow users to connect to a MUD software. The client’s primary tasks is to send and receive Input/output between the server and the user. The MUD server exists on one machine, while the client is typically run by users from their machines. Many clients today, are being upgraded in order to improve the user’s communication. Some of these features are: filtering users output by separating the different outputs in separate lines, and providing users with macros to execute several commands with just few key presses.

Once connected, users on the MUD are provided with a brief description of the MUD, its purpose as well as other instructions about how to get help about using different commands, such as those used for communication, movement, paging etc. Several MUD sites also, provide their first time users with behavior guidelines in order to keep a suitable environment for discussions.

The main features of MUDs therefore can be summarized in the following points:

- They are interactive in real time where all participants can exchange messages immediately. This provides on-line students with conditions similar to face to face classes, where spontaneity is the main characteristic of such discussions.
- A MUD environment enables users to make meetings as private or as public as they want. This is very useful for on-line campuses, where classes can be easily separated from other campus areas. Also this allows for real time group discussions and group work to be held on-line.
- A MUD environment enables MUD-mail for personal messages and bulletin boards and mailing lists. This promotes a highly interactive environments.

- MUDs are multi-user capable, allowing thousands of users to communicate and exchange information together. This feature permits students to exchange ideas in real time with experts and other students from all around the world, in which case discussions are enriched and are moved beyond the class limits.
- MUDs allow users to download multimedia files. This allows the instructor to better simulate face-to-face classes, and to support their lectures with the necessary multimedia documents. On that account, much more courses in different areas can be taught on-line, such as music, biology and arts classes.
- MUDs sessions can be recorded for further use. Telelearning students, therefore, can retrieve previous class sessions and discussions for reference. Clients are also capable to save transcripts of files providing users with a permanent archive for their use.

2.2.3 MOO: MUD Object Oriented:

MOO stand for Multi User Dimensions-Object Oriented. As its name indicate, a MOO is a variant of a MUD, but it include more possibilities for interaction between MOOers. MOOs, like MUDs are text based virtual reality sites allowing users from different locations to connect through telnet or any other client, log into a virtual room and communicate and discuss in real time. Users are able to move from one room to another, talk, page and mail people in other rooms. The MOO database consists of a basic set of programs and functions. All other operations rely upon these functions and programs to operate. A computer which is being run with the MOO operating system is called the MOO server. Unlike MUDs, MOOs allow users to build, interact and manipulate cyber objects (including furniture, pets, and imaginary objects), make additions to the landscape, in addition to chatting with other people. In fact it is the programming interface which allows MOO users can freely manipulate and extend the environment by creating their own objects.

There are different user levels in a MOO. The highest level is that of a wizard. The wizard is a moderator, who is in most cases the instructor or a system operator helping the instructor. The wizard has to build, or program the MOO and to understand the LPC programming language. This might be time consuming and difficult for many instructors, with very little or no computer literacy.

The powerful MOO features resulted in the creation of very flexible environments, which are proving to be of big assistance to on-line academic institutions. According to those who have experienced these environments, MOOs provide a metaphor of real life by allowing users to interact with objects as they would do in real life, and allows the simulation of real environments. The Virtual On-Line University and the Diversity university are totally on-line universities which are using MOOs for their academic

operations. Many other partially on-line institutions and instructors are also moving more towards MOOs as a basic tool of augmenting their classes.

Some examples of how useful this environment is are the virtual objects which can be designed during a MOO session. A virtual slide projector, for instance, allows the instructor to show every student on-line a series of slides. These slides are basically short paragraphs of prepared text, that the instructor uses to emphasize specific points. Another virtual tool is the virtual video recorder which tapes the lecture conversations and stores them in a virtual tape library. Tapes of each session can be later retrieved by students whenever needed. Other virtual designs include: virtual theaters for students presentations, video cameras, TVs and conversational robots acting as a vocabulary tester, tutor, room guide, and information assistant for students.

Like MUDs, most MOOs have a basic theme around which they are developed and built. Diversity university, for example, is an educational MOO, so the building and development has been that of a college with many offices, classrooms, a student union, student lounge as well as other areas such as those found in a real campus. Diversity University's Web page is available at: <http://www.du.org>

An extensive list of MOOs and MUDs is available at: <http://www.itp.berkeley.edu/~thorne/MOO.html>

Figures 2.1 and 2.2 demonstrate a telnet window of a MOO, and a MOO Web interface with VRML integration.

```

HTTP/1.0 200
X-moo:
                                WELCOME TO
                                DIVERSITY UNIVERSITY Main Campus
                                Address: MOO.DU.ORG (128.18.101.106) 8888
                                Web Gateway: http://moc.du.org:8888/

.
Diversity University MOO campuses are Internet locations for serious
experimentation in network-based, interactive teaching, learning and social
services. Those wishing to further this community development are welcome!
To preserve this atmosphere the administration reserves the right to do
unannounced monitoring as required. Information gathered will be treated
in strict accordance with the Privacy Act.
.
Free MOO Basics lessons: contact CindyT or MattWright online, or du@du.org
.
The DU administration would like to thank the many volunteers contributing
time and effort to further this vision. We would also like to thank SRI
International, Embry-Riddle Aeronautical University (ERAU), and the
Annenberg/CPB Project for their support in this venture.
.
Supporters of this project are not responsible for the content of any material
which may be found on this system.
.
co guest - to have a look around | @who - to see who is online
                                | @quit - to exit Diversity University
.
connect guest
Connected to moo.du.org:8888

```

Fig 2.1 : telnet window of a MOO
Source: <http://www.du.org/java/CupOmud/snapshots/>

Fig 2.2: Web interface of a MOO with the integration of VRML

Source: <http://www.du.org/java/CupOmu/snapshots/>

2.2.4 Advantages of text based conferencing Internet tools:

Text based conferencing systems are very suitable for Internet-based telelearning settings. The increasing number of on-line courses offered using these tools confirms this idea. It is mainly their synchronous characteristic which is contributing to their popularity. Being able to interact in real time, significantly promotes the flow of information interchange between class members.

Some of the conveniences that text based conferencing software offer to the telelearning community include:

- The low bandwidth and low cost requirements of the text based conferencing programs enable students from around the world to have access to on-line classes, especially those who have difficulties in accessing the conventional means of education.
- The real time aspect of these tools combined with the ability to access Web resources enables students and researchers to share information and to make quick referrals to relevant Web material. This powerful feature can significantly increase the effectiveness of an on-line course, and improve the learning process.
- MOOs are most appropriate for same time different place communication, therefore it is appropriate for telelearning and on-line courses, where it is desirable, to have the class together for interaction.
- MUDs, MOOs and IRCs allow for immediate responses and quick question-and-answer sessions, which is a very necessary and useful feature for on-line telelearning. A telelearner at home can connect

to a campus computer, telnet to a MOO, MUD or IRC site and join his fellow classmates in synchronous conditions.

- Because responses are almost immediate, these environments are more revealing of the students' reactions to the received material and discussions, knowledge and behavior. These tools, therefore, can be very useful for remote testing.
- Real time communication allows students to interact and collaborate easily. Students can work in groups on-line, which improves distance communication and saves times as opposed to group work using asynchronous tools such as e-mail.
- Group work held on-line takes place in separate rooms and synchronous discussions can take place in conditions similar to face to face classes.
- MUDs and MOOs can be configured in a wide variety of ways, and can provide users with a very flexible interactive environment. Users can perform any form of interaction including talking to objects, looking at bulletin boards, participating in discussions , and walking around.(This flexibility however comes at a cost, MUDs environments design is very time consuming(designing a small MUD can take up to 200 hours))
- Versions of lectures and messages can be accessed later by students and teachers whenever they want. These programs, therefore, can be used as both an asynchronous and synchronous environment.

2.2.5 Common issues with text based conferencing Internet tools:

Internet text based conferencing software also have some limitations:

Programs operations related issues:

- Even though most of the systems are able to accommodate many participants, a classroom full of about 300 student having a conversation all at once would be chaotic. In case of on-line classes, it would be better to limit the number of student in a class, depending on the instructor's group management skill. These environments, however, are suitable for group work , where the number of participants is small.
- User training is very important in these environments, in order to allow them to make use of the system at its full potential. While the set of commands required to effectively use MUDs and MOOs are limited in number, users need practice and instruction before using them, especially when dealing with young students. One significant weakness of MOOs, is that its commands always use the @ character, something that a user can easily forget during their chat.

The IRC also presents some similar difficulties where users are required to precede their commands with /. New IRC clients, today are being improved and are becoming more user friendly, by introducing

the option of using buttons instead of characters. User training, however, is still very important and essential, to ensure smooth and effective chat environments, which can be time consuming.

- For many users, the fact of communicating by typing impedes smooth communication and can shift the conversations interest to typing .
- Text based conferencing tools consist of reading lines of text and then typing it fast enough before it scrolls away. Communication therefore is likely to evolve into a competition of who can write faster or better, which can be very disorienting.
- Typing is time consuming and cannot always express what a user is thinking.
- Many users might not be able to express themselves properly by just typing their thoughts.
- Talking with people you don't see might be frustrating for some users.
- Having multi-party discussions can cause some interaction problems such as: confusion of discussions, risk of offensive and inappropriate behavior, and the dominance of some members on the discussion.

These problems require a well skilled discussion moderator to mediate and to monitor discussions, who can be the instructor in case of on-line classes. Moderator skills, however, are not easily acquired, and need a lot training and effort.

- Learning to administer a MUD, MOO or an IRC is very difficult and time consuming. This involves making sure that the database is backed up, learning the MUD's(or MOO) programming language in order to extend the environment.

Technical issues:

- In order to run a text base conferencing software a server is required. The operating system is also important. While MUD software exists even for DOS-based machines, the possibility of involving too many participants at the same time requires a powerful server. Most MUDs and IRCs run on UNIX or Linux software.
- Connection speed is also an important factor to consider. With the increase developments and broadband feature such as Virtual Reality, and downloads of graphics and audio and video clips, students will need to upgrade their Internet connections to a higher speed.

Despite all these issues, the increasing popularity of these tools for delivering on-line courses prove their usefulness in telelearning environments. The continuous developments and upgrades added to these programs, such as the integration of Java programming language which enables embedding Web pages, and the more user friendly user interface designs, made these areas more flexible and convenient for on-line students and instructors. Moreover, the low cost requirements of bandwidth and equipment for running any

type of multi user virtual environment, strongly encourages academic institutions to employ these tools for their on-line courses delivery.

One case example is the Diversity University or DU. According to its developers, DU was the first MOO to be designed for classroom use. It is a non profit on-line instructional organization, with the main objective of increasing the availability and access to knowledge to people all around the world and to meet the different telelearning needs of people and individuals.

DU' s mission statement as reported by its board is:

The mission of Diversity University is to develop, support and maintain creative and innovative environments and tools for teaching, learning and research through the Internet and other distributed computing systems, and to guide and educate people in the use of these and other tools, to foster collaboration in a synergistic climate, and to explore and utilize applications of emerging technology to these ends in a manner friendly to people who are disabled, geographically isolated or technologically limited

The primary medium used by DU users is the MOO environment. DU has three main active MOOs: DU-Main MOO, DU-South MOO and DU-Press MOO. DU-Main MOO is the only open site for public access. It is designed as a campus, with several buildings such a student lounge, an administration, a gym and a football field as well as different faculty departments. Within each building, several educational projects are included which were created by the DU community and that can be used as part of a class or for simple on-line discussions. DU-South is a Research and Development MOO where programmers can meet for collaborative research, train, experiment and create. DU visitors can access the DU MOO either using the telnet program to access DU using text only, or using a Web window for a multimedia communication.

Thousands of students, teachers, and administrators worldwide, today, are using DU classes, literature, and consulting services. The medium's easy access coupled with the potential benefits it offers to the educational community are the main reasons for its increased popularity.

DU's Home page address is: <http://www.du.org/index.html>

2.3 Audio-conferencing tools:

Because text based conferencing programs can be time consuming due to the typing process, many Internet users are using audio-conferencing tools. Instead of spending the time writing, students can use their time watching, listening to the instructor and their class mates, and talking with other class members, which is somewhat similar to a traditional face to face lecture.

Good quality audio in an audio-conference is very necessary. Humans are intolerant to audio delays, especially when it comes with video and is desynchronized with the video stream. In three studies conducted by Tang, John C. et al.(1993), analyses found that noticeable audio delay in video conferencing made it difficult for the participants to manage their interactions. It also showed that users prefer having audio with minimal delay over having audio in sync with video if a noticeable delay is imposed.

Audio-conferencing software present a big potential for Internet users, including educational institutions. One of their main advantages is that they are cost effective, low bandwidth and cheap to use. Much of the audio-conferencing software are available for users for free and require basic hardware. All that a user needs is a PC or a Mac running Windows or OS/2, a microphone, a SLIP or PPP net connection, and a modem or a LAN. Since most programs compress the voice message, low bandwidth connections are in many cases enough to receive acceptable voice quality. Some of the widely used audio tools are: Netphone, SpeekFreely, and TeleVox. Figure 2.3 is an illustration of the TeleVox audio-conferencing tools and its different features.

Fig 2.3: TeleVox window and its different features
Source: <http://magenta.com/cyberphone/teleweb1.gif>

2.2.1 Advantages of audio-conferencing software:

Some audio-conferencing software, such as Internet Phone, can be run on top of text based conferencing tools such as IRC, and provide users with a list of the listeners and the topics discussed. In an on-line class setting, this feature allows instructors to better manage their lecture, and to use their time more efficiently.

For instance, oral discussions can be used during regular class times, while textual communication can be used during tests and exams. Also, this can be very helpful for students who have a problem with writing.

2.3.2 Issues with audio-conferencing software:

One main issue with audio-conferencing software is the lack of compatibility of the different audio-conferencing software. In many cases participants in an audio-conference can only communicate if they are using the same audio-conferencing software. Others can only talk to software which use the same protocol.

The new RTP (Real Time Protocol) is presenting new opportunities for Internet audio-conferencing users. RTP is a standard protocol which is already being used by the audio-conferencing tool Vat, as will be explained later in section 2.3.2 "The MBONE". RTP is emerging as a new protocol which provides audio-conferencing tools which currently can't talk to one another, with a better inter-operability to bridge that gap and to smooth out audio communications.

Another problem is that many of the available audio-conferencing tools are half duplex. This means that participants should wait until the other party finishes speaking to be able to speak. If used in telelearning, this feature can cause several conversation problems. By way of illustration, students will not be able to ask questions or to comment only after the instructor finishes his explanation, while many questions can be very important in classifying certain points if asked during the instructor's speech. As a result, the on-line lecture effectiveness can be significantly lower than that of a conventional face to face class.

Fortunately, many audio tools are being enhanced today by adding full-duplex capabilities, such as the Internet Phone. Full duplexing means that both participants can speak at the same time. In case of an on-line class, the instructor's role is to manage and organize conversations.

2.4 Video-conferencing tools:

Video-conferencing technology is another important resource which is predicted to be an important element of a networked on-line educational environment. Using video in support to audio and text based interactions, adds value to a conference and significantly enhances communication. Implementing real time visual interaction methods makes conversations more personal and effective by allowing participants and in our case, students and instructors who might never meet on a common site, to see their classmates and to interpret any nonverbal language such as gestures and expressions which are very important cues in any real time interaction, and cannot be provided using other conferencing tools.

Using the traditional methods of video-conferencing (i.e. through satellite or telephone communication systems), costs of equipment, high user fees and dedicated settings and rooms, are in many cases prohibitive for academic institutions with limited budgets. These costs combined with the time consuming required preparations for a video-conference, have limited the use of video-conference.

Several proprietary software such as VDOnet, have been recently released in order to deliver real-time video. Users, however, have been experiencing several problems with these tools due to many reasons:

- These programs are proprietary and not standards-based. This is a very discouraging factor for using them in a telelearning environment. Using non standards-based tools means that all conference participants should be using the same tool in order to interact. This requirement is very difficult to satisfy in a telelearning environment, since it might not be possible for all students to acquire the same software.
- They use a unicasting network delivery mechanism, which consumes huge amounts of bandwidth and server CPU cycles. This significantly increases delivery costs, and lowers the efficiency of real time transmissions, especially for a telelearning environment where time lags are intolerable, and images and sound quality can be very critical.

The need for better quality transmissions, and wider access to more participants and students has been encouraging the development of new low cost video-conferencing software and technologies over the Internet. The two main tools which will be discussed under this section are: CUSeeMe, the first video-conferencing software over the Internet, which has been operating within the Internet unicasting environment, and the Multicasting Backbone, which is at the stage of being more and more integrated in the Internet environment in order to provide high quality and effective video-conferences over the Internet, using a new data transmission technique called multicasting.

Internet video-conferencing has many powerful aspects which can be used effectively in a telelearning environment. Instructors at any time can communicate with their colleagues on campus, or throughout the world, to consult, exchange ideas or to teach. Collaborative learning between students and several classes is also possible using the new Internet tools. Instructors can hold on-line live office hours which allow for a more immediate and interactive communication than e-mail or text based conferencing, and can perfectly simulate face to face settings.

Many Internet users today have already performed live video-conferences over the Internet, despite the network's limitations, such as low bandwidth and lack of support to real time applications. Emerging standards such as IP Multicast, Resource ReSerVation Protocol (RSVP), Real Time Protocol (RTP), as well as the continuous upgrades in data compression techniques of the already existing video-conferencing tools will soon make video-conferencing a common application over the Internet.

2.4.1 CUSeeMe:

CUSeeMe is an Internet based videophone platform, developed at Cornell Information Technology (Cornell University, Ithaca, New York) to provide the Internet community with inexpensive multipoint computer conferencing. CUSeeMe was the first software in the Internet that allowed multi-party video-conferencing. So far, CUSeeMe enables viewing up to 8 participant windows, but allows for unlimited number for audio and talk window. The CUSeeMe enhanced version released in February 1996, has added several features to CUSeeMe making it more convenient for on-line video-conferencing. Since its appearance in 1992, CUSeeMe has dramatically evolved. Its primary applications have been telelearning, graduate supervision, and research collaborations.

Figure 2.4 shows a CUSeeMe video-conference snapshot:

Fig 2.4: A view of a CUSeeMe video-conference
Source: <ftp://gated/cornell.edu/pub/video/html/jetterman.html>

How it works:

CUSeeMe consists of a client program and a server-like component called a Reflector. Video-conferencing applications, such as CUSeeMe, require continuous bandwidth. Technologies such as Web browsing and file transfer utilities use a connection-based method like the TCP protocol and need packet confirmation and loss control. CUSeeMe uses the User Datagram Protocol(UDP)instead which ensures a continuous

stream of packets. This protocol is better suited for video-conferencing which has continuously changing data feeds, by giving precedence to new data over confirming what was sent. The UDP capabilities allowed the development of a server based application known as the reflector.

The Reflector is a server-based application which allows CUSeeMe clients to have all types of group communication(one-to-one, one-to-many, and many-to-many), depending on users needs and hardware capability. It is responsible for routing multiple streams data (video, audio and text) during a conference and reflecting them to all participants concurrently. Reflectors were invented because of the lack of support for IP multicasting in the Macintosh operating system kernel. Without reflectors, only point-to-point links connecting two CUSeeMe users are possible at this time. Compared to traditional multicasting where several copies are made at the sender's site, reflectors improve network bandwidth capacities by efficiently managing transmissions and simulating multicasting, by receiving one data stream and reflecting it to multiple sites.

Reflectors act as intelligent broadcast stations providing conference and network management tools for the network manager. Conferences can be configured to be private with password protection. This option is very important when holding small class discussions or on-line oral exams where presence should be restricted to class members only.

For large conferences, reflectors can be chained together, allowing more attendees to participate. Chaining also helps distributing the network load over a number of subnets within a WAN. Applied to a telelearning environment, classes with a large number of participants can be held, and on-line projects and real time interaction between remote classes and/or schools from different areas around the world, are also possible, which significantly adds value to on-line telelearning settings and to the students' experiences.

As illustrated in Figure 2.5, the reflector takes one CUSeeMe video input stream from the remote video source, makes multiple copies of the video stream for each user who wants to receive the video stream, then sends them to the appropriate remote destinations.

Fig 2.5: How a CUSeeMe reflector operates

Reflectors are also effective in managing bandwidth. When network traffic is heavy and packet loss of individual users is running too high, the reflector can adjust the transmission rates. For example, when the first person is speaking, the related audio is prioritized (followed by the video), over the other conference attendees. Also, the data for supporting applications like whiteboard or chat are more efficiently managed by reflectors.

2.4.1 System requirements:

Receiving CUSeeMe video only requires a personal computer with a screen capable of displaying gray scale images, the CUSeeMe software which can be downloaded for free from the anonymous ftp: prince%ftp.gated.cornell.edu (132.236.199.65), and a connection to the Internet. No extra hardware is required.

Sending a CUSeeMe video stream requires the same tools required for receiving video, in addition to a camera, such as the Quickam, a golf ball sized black and white digital camera currently available for \$98 US, and video capture hardware such as SuperMac VideoSpigot board.

In a CUSeeMe conference, each participant can decide to be a sender, a receiver or both. Once connection is established a video image of each participant appears on the computer screen CUSeeMe displays 4-bit gray scales video windows at 160x120 pixels or at a double that diameter. Digital video images are captured from camcorder or similar inexpensive video source fed into a digitizer and then compressed by the software. In order to achieve a more efficient use of bandwidth, CUSeeMe sends only changes to the image, so that a still background is not repeatedly transmitted. However, even acceptable video images are possible with 14.4 kbps modems, a five person video-conference requires five times the bandwidth.

Audio information is captured using the sound input hardware available on the computer. Audio packets are compressed and transmitted directly to the other connected parties either on a push-to-talk (using a mouse button) or a "squellch" (when sound is high enough) basis.

Auxiliary data is a relatively new feature in CUSeeMe. This data includes textual chats, annotations and images. Currently, two built in tools use this feature a "talk" window or a whiteboard, in which text conversations can be logged and organized and an image transmission window in which allows large, high resolution images to be transmitted and annotated. This feature has proved to be very important for medical classes and remote diagnosis of medical images.

The following is a list of the system requirements for using CUSeeMe, they are classified into general requirements and computer system requirements.

- General Requirements involve: TCP/IP network and node address, 10 MB hard disk space, a modem bandwidth of 28.8kbps or better; 14.4kbps or better for audio only and a SLIP/PPP compatible
- Computer system requirements are listed in table 2.1

Table 2.1: CUSeeMe user requirements

PC requirements	Macintosh requirements
<p>To RECEIVE:</p> <ul style="list-style-type: none"> • 486 DX/66 or higher processor recommended (video send/receive, audio send/receive) • Windows 95, Windows 3.1, Windows NT, or Windows for Workgroups 3.11 running in enhanced mode • Minimum 12 MB RAM (16 MB or more recommended) <p><u>video:</u></p> <ul style="list-style-type: none"> • 256-color (8-bit) video with 640x480 or higher resolution <p><u>audio:</u></p> <ul style="list-style-type: none"> • Sound card with 8-bit sound with microphone input (needed for sending) and speaker output <p><u>IP network connection</u></p> <ul style="list-style-type: none"> • Windows Sockets compliant TCP/IP stack or PPP • Bandwidth of 28.8 Kb or better (14.4 Kb for audio only) <p>To SEND: Equipped to receive as outlined above with the added requirements:</p> <ul style="list-style-type: none"> • Video camera with serial port digitizer, or • Video camera with standard NTSC output (like a camcorder) and <ul style="list-style-type: none"> • Video capture board not using overlay technology • RCA cable (composite video), or • S-video if capture board supports it • Recommended: Separate microphone or headset for better "phone-like" use 	<p>To RECEIVE:</p> <ul style="list-style-type: none"> • Minimum: 68030 processor with 25MHz clock or faster • MacOS System 7 or higher • 10 MB of free hard disk space • 5 MB application RAM for color video-conferencing features; Grayscale conferencing can be accomplished with less memory; 8 MB application RAM for full features, including WhitePineBoard <p><u>video:</u></p> <ul style="list-style-type: none"> • Ability to display at least 16 levels of gray (e.g., any color Mac), • QuickTime v2.0 or later. <p><u>audio:</u></p> <ul style="list-style-type: none"> • Sound Manager v3.0 or later, Speakers or headset to receive audio (built-in on some models) <p><u>IP network connection</u></p> <ul style="list-style-type: none"> • MacTCP v2.0.6 or higher, or Open Transport v1.1 or higher • Bandwidth of 28.8 Kb or better <p>To SEND: Equipped to receive as outlined above with added requirements:</p> <ul style="list-style-type: none"> • Video camera with serial port digitizer, or • Video camera with standard NTSC output (like a camcorder), and video digitizer (AV-Macintosh has built in video digitizer) <p>Recommended: separate microphone or headset for better "phone-like" use</p>

Source: <http://face2face.com/vidprod.html>

Advantages of CUSeeMe:

Using CUSeeMe for holding on-line lectures and discussions can be very beneficial for creating a dynamic learning environment, and provides users with a powerful tool for efficiently transmitting learning material and information in general. The following paragraphs examine some of CUSeeMe's benefits.

First, the principals of CUSeeMe developers have been to provide a wide user community making it compatible with different computer platform. Earlier desktop video-conferencing software was oriented to powerful workstations not generally available to primary and secondary school levels, and to the common Internet users. CUSeeMe uses a simple but efficient video frame differencing and compression algorithms, which has allowed multiple party video-conferencing to users of low end desktops computers, and has enabled a broader participation in the desktop video technology.

Further, CUSeeMe was built on the Internet's open technology, and uses standard protocols for data transmission. This means that students and users from anywhere in the world can use it, as long as they have an Internet access and the required tools to receive a CUSeeMe stream.

Likewise, the original version of the software was distributed as "freeware" from Cornell University at no cost. Even though the new Enhanced CUSeeMe version is being sold, its sale price is still affordable for students with limited budgets. Moreover, the required hardware is very basic and cheap. As a result, students with limited budgets are able to hold real time live video lectures, and to benefit from all the powerful aspects of the software.

The new enhanced CUSeeMe version allows for a better bandwidth management, which is a very significant element to maintain smooth connections, prevent interruptions and assure continuous transmissions of data during important on-line sessions such as presentations and on-line exams.

The main characteristics of the enhanced bandwidth management are:

- First, it offers scalable compression and decompression "codec" technology which allows each user to control their own bandwidth usage. For instance, modem users, such as on-line students, can select the codec that offers the best quality for low bandwidth transmission. They can also set minimum transmission rates that will adjust to the variety of network connections they may be using, i.e. ISDN, modem, LAN connection. If network traffic is too heavy, transmission remains at the lowest setting and only moves up when the network is less congested.

- Also, in network conditions where a significant amount of data is lost, Enhanced CUSeeMe uses packet loss information to automatically adjust the video and audio transmission rates. As packet loss increases, CUSeeMe adjusts the bandwidth by reducing the maximum transmission. The audio quality is automatically insured by prioritizing audio packet transmission over video.
- And finally, the software uses "Forward Error Correction" techniques to recover from audio packet loss; thereby maintaining quality in adverse network conditions.

Many other meaningful enhancement to the new CUSeeMe version, which are also of significant benefit to on-line telelearners include the following:

- The ability to support multi-platforms.
- The option of having an unlimited number for audio and talk window, in addition to viewing up to 8 participant windows. Thus, even if some students do not support video, they can still take part in the on-line discussions by interacting with audio and text.
- The use of a whiteboard: this tool is very helpful for on-line presentations where the instructor needs to display slides and make annotations during a lecture. Also, students can use it during on-line group discussions for brainstorming and collaborative work;
- The Mosaic browser support for direct launch of CUSeeMe from Web page. During a conference, lecture participants, therefore, can have smooth access to Web resources and make quick downloads of relevant material, which adds value to the lecture.
- Improved color support(24-bit true color and 4-bit greyscale). Adding color to a video-conference session adds value to presentations such as during medical and arts classes where color is very necessary when presenting lecture material.
- Including a phone book which allows saving, adding and exciting participant addresses and reflector sites. This tool can be very useful for the instructor, as well as to students, to keep a record of each other's references.
- An easier, user friendly installation with TCP/IP network software, avoiding therefore installation problems for students with very basic computer literacy.
- Enhanced security: Security has been always a big issue for CUSeeMe. In fact, anyone who connects with an active reflector can view the ongoing conferences. In order to overcome this problem some alternatives have been designed:
 1. The caller ID feature: Using the caller ID, a message alert box is popped in informing participants of incoming connections.

2. System administrators who manage reflectors can also help providing a level of security, by configuring the reflector to accept a specific list of IP addresses, such as those of only registered students. System administrator can further restrict remote access to the Reflector by adding password protection. Therefore, it is only those who possess a password can access the reflector site and attend the ongoing conferences.

Issues with CUSeeMe:

Like any other developing technology operating within a dynamic environment such as the Internet, CUSeeMe still has some problem areas, which have to be worked on.

In many cases, communication between sites is not completely fluent. Because of lags in time, each person needs to signal when they finish speaking. These lags can be disturbing during on-line music lectures where continuous sound is required. Moreover, humans are less tolerant to audio lags than to video lags. The newly introduced UDP protocol, however, was developed to eliminate this problem and in order to produce a smooth and continuous video and audio conversations.

Another drawback, which can also apply to any video-conferencing tool over the Internet is that on-line video-conferencing is more invasive than other on-line communications such as audio and text based tools. On-line users can easily forget that they are on display, forgetting to be attentive about some manners and behaviors.

Having participants on display can bring in face to face communication problems such as racial and gender stereotypes, and the discomfort that some individuals experience when making presentations for a large number of people. In text based conferences these problems are very unlikely to occur primarily because of the lack of the audio and the visual contact.

One technical issue which can affect the flexibility of CUSeeMe operations is that the CUSeeMe reflector runs only on UNIX machines, and configuring the reflector is a difficult task, as it is not user friendly and not very well documented. A system administrator, in this case, is required to configure the reflector, which can represent extra costs.

Security always remains the main issue for applications running on a complex network such as the Internet. Until the enhanced CUSeeMe version with its improved security features becomes commonly used, most of CUSeeMe conferences will still lack the element of privacy. Currently any CUSeeMe conference can be viewed by anyone who connects to an active reflector. To solve these problems, system administrators

should actively start upgrading their reflectors by including the new security measures. For a point to point conference, privacy and security of the transmitted data, will be always dependent on the security settings of the users' networks and that of the Internet as a whole.

Bandwidth is another important point of great concern for individual users, especially for students using simple 14.4 or 28.8 Kbps modems. During a video-conference, each open window on the user's work area, consumes a portion of the bandwidth that CUSeeMe is using for communication. In order to reduce the bandwidth consumption, it is important to monitor the number of opened windows. This can be either by simply closing some of the windows, or stopping the reception of video streams. Setting transmission and receive caps also helps to conserve bandwidth. The problem, though, is when the user has no idea about the appropriate transmission and reception rates which should be set. On-line assistance in this case is required in order to guide users to make the best use of the tool.

Case examples of the use of CUSeeMe within a telelearning environment:

Despite these issues, CUSeeMe powerful features and its continuously enhanced capabilities is encouraging more people, especially the educational community, to adopt the tool for delivering education. Many institutions have been experimenting with the tool for some of their courses, and will be soon using it as a basic element for class discussions and communication. Also, several instructors have integrated the tool for the course delivery and are using it to communicate with their students. The following are two case examples where CUSeeMe has been used for holding on-line lectures.

During the months of August and September 1994, a dozen students from different parts of the world, taking the undergraduate Cognitive Psychology course with the Virtual Summer School (VSS) for Open University in United Kingdom, were able to attend their class on-line, using their computers and the CUSeeMe software. Students could participate in class discussions, and attend a guest lecture transmitted from the University of California at San Diego.

David Fetterman, from Stanford university, introduced the tool to his ethnography class students and used it in the classroom, between other class rooms and to facilitate communication. Despite being away, the instructor was able to hold real time live office hours with his students. The new interactive medium enabled him to maintain all his campus schedule of duties and appointments and to avoid time lost to travel. According to Fetterman, "...Internet video-conferencing (has been) enhancing (the class members') educational experience, allowing a more immediate, more interactive form of contact than e-mail. He finds that using CUSeeMe, electronic communication becomes more personal and a lot more effective when tone nuances are heard and nonverbal language such as gestures and facial expressions are seen. The tool was

also used during multi-site research projects with other instructors. Participants shared research results, maps and, illustrations instantaneously. This experiment according to Fetterman, can have considerable implications for international research and cooperation. Fetterman also used the tool to give on-line workshops for students in remote classes.

Despite the several technical problems encountered during his experience, Fetterman's conclusion was that: once the technology and the tool become more mature, educational community can fully benefit from the potential advantages of CUSeeMe. Using this tool can significantly enhance exchange and expand instructors' reach and accessibility worldwide. As a result, international collegial communication and research can be enhanced, opening new applications and opportunities for educational exploration.

2.4.2 The MBONE:

Why is the Web unsuitable for real time multimedia?

Even though the Web is working on some solutions to support live multimedia interaction, many limiting factors are still making it unsuitable for real time multimedia. Today, video and audio over the Web is limited to prerecorded and archived video and audio clips, which are retrieved whenever needed. Current browsers are excellent for browsing static information over the Internet. Still image files are generally small, so a user doesn't need to wait too long to view them, but if the file is downloaded from a geographically heavy site, the process becomes very frustrating. Although animation and audio are possible over the Web, sending and receiving audio and video files requires faster connection, as there are currently very slow. These problems severely limit the effectiveness of the currently available on-line conferencing tools especially those using multimedia support.

Another reason which prevents the Web from being a suitable medium for real time multimedia is the Transfer Control Protocol(TCP). The HTTP protocol is the transfer protocol used between WWW clients. HTTP uses TCP as the primary protocol for reliable document transfer. TCP is unsuitable for real time audio and video for several reasons.

First, TCP uses its own flow control of data streams. This mechanism destroys the time dependent relation between data frames and audio packets. Also, since real time audio and video streams tolerate losses, reliable message delivery provided by the TCP is therefore not required. Finally, TCP retransmission causes further jitters and skew between frames and externally between audio and video streams.

These problems, coupled with the increased importance and demand for real time multimedia over the Internet, accordingly encouraged research about new solutions which would allow for an easy transmission of real time applications via the Internet

Introducing the MBONE:

The MBONE stands for the Multicasting backBONE. It is a virtual network constructed on top of the existing Internet, consisting of hosts and routers connected to the Internet and communicating using a technique called IP multicast. It is a technology which facilitates live interaction and large scale distribution of multimedia material, including live audio and video files exchanges, and sharing any type of digital information, under the condition of providing all these services at low costs and with high convenience.

The term Backbone implies that the service is central and important to the network. The Multicast is used because it provides one to many, and many to many network delivery services, such as audio, video, image and text files, which require delivery from source to destination within a limited time, and which need to be shared with several other hosts simultaneously.

These features, coupled with the universal reach of the Internet and the convergence of communication with visual interaction, is making the MBONE an exciting possibility for the Internet, in the near future, to move one big step beyond its current limits, by transforming the Net into a universal live multimedia medium.

The MBONE Evolution:

The MBONE originated from the Internet Engineering Task Force (IETF) experiments in an effort to multicast audio and video over the Internet. The first audio transmission of a conference over the Internet took place during the Spring 1992 IETF conference in San Diego, while the first video transmission took place during the next IETF conference in Boston. Since then, the MBONE has undergone a phenomenal growth over the world and is already deployed and used in all the continents. As of February 1997, the public part of the MBONE is supported on more than 3,200 public networks and boasts more than 10,000 organizations connected worldwide. The Internet multicast technology is deployed today in the Internet infrastructure, all the way from switches and routers to the operating systems and desktop applications. To date, the MBONE has been primarily used over the Internet for conducting multi-party video-conferences. Some, but not all, ISPs already support the handling of multicast IP packets. As more networks are upgraded to support multicasting, the MBONE and the Internet will eventually be a single entity.

Despite the availability of several other video-conferencing tools, such as RealAudio and VDOnet, their network delivery mechanism is very inefficient and suffers several problems. Moreover, these tools are both proprietary and not standards-based. Internet multicasting, on the other hand, is already a standard, which was developed and tested by the Internet engineering community.

Even though it is quite easy today to create, manage, distribute and access multimedia material using the MBONE, it is still undergoing some difficulties which are very likely to be solved once the technology becomes more mature. Despite the developers work to upgrade the MBONE and its tools, a better Internet infrastructure is required in order to make the MBONE more popular and commercial. This will be discussed in more details in the following sections.

Today, the MBONE is mainly used by academic and research institutions. Many trial projects and live research conferences are being held over MBONE via the Internet. Even though most of the conferences are held by the IETF to discuss Internet related issues, many other conferences are employing the technology for collaborative educational projects, medical imaging, data analysis and groupware.

One prototype of MBONE applications for telelearning and collaborative research is the NASA's JASON project. The JASON project is an annual, two week expedition to remote areas in the world, which is multicast to a network of educational and research institutions around the world, including the United States, Canada, Mexico, Australia, as well as many other countries in Europe and Asia. Its goal is to allow students to interact with scientists using state of the art interactive technologies, such as the MBONE. The 1995 expedition topic was about volcanoes of Hawaii. The session was announced on-line in a press release, inviting educational institutions, teachers, students and researchers, who have access to the MBONE to take part in the live session. Using the MBONE, hundreds of thousands of students from around the world were able to participate in the session and interact with the scientists on the site. Students were even able to control ROVs-Remotely Operated Vehicles- from their remote locations.

Successfully realizing such events requires significant planning and organization. The MBONE potential benefits for the educational community, however, make these preparations worth the effort.

Technical Aspects:

The MBONE consists of a subnet of Internet multicasting routers that can understand class D address and can process multicast packets. Initially, the MBONE was called virtual because the Internet routers and desktop operating systems could not handle and process multicast packets. The MBONE, therefore, was

layered on top of the Internet sharing the same physical media, while allowing multicast packets to travel through routers which are initially set up to handle unicast packets. This was done using a scheme called tunneling. This has considerably changed, however. Today, more commercial multicasting routers and several operating systems which are able to handle multicasting, are available on most desktop computers such as UNIX workstation, Windows PCs and Macintosh, and are being deployed in the Internet. Consequently the MBONE is relying less on non multicast equipment resulting in more effective real time conferencing. Figure 2.6 illustrates the topology of the MBONE and the routing of a multicast packet.

Fig 2.6: Multicast packet path over the MBONE

As shown in Figure 2.6, sender A can send a multicast packet to receivers B, C, D and E in networks C and B, without replicating the information packet. The replication only occurs at the MBONE service provider multicast router Mr2. Mr2 makes two copies of the information packet: one for LAN B and a second one for LAN C and sends them over the MBONE tunnels. Each network's multicast routers (MR3 and MR4 in this case) forward the received packet to the appropriate receivers.

What is Multicasting?

The usual way of delivering packets over the Internet is unicasting. When a packet is unicast it is delivered from the source host to the destination host. When a packet is broadcast it is delivered from the source host to all attached hosts. Multicasting, on the other hand, occurs when a packet is passed to selected destinations only on the network. Figure 2.7 illustrates the three modes of delivery.

Fig 2.7: packet delivery methods over networks

As shown below in Figure 2.8, traditional multi-party communication follows the three following steps:

1. First, the packet is duplicated depending on the number of destinations
2. Second, the copies are forwarded to each destination.
3. Third, the packets are processed by each receiving host

Therefore, as the number of destinations increases, network traffic increases exponentially, leading to network congestion. Moreover CPU processing at each site increases. This makes the unicast based communication for multi-party communication unsuitable.

Fig 2.8: Stages of a traditional multi-party communication

Using the multicasting technique solves this problem by eliminating the replication of packets from source to destination. The host no longer sends the packet to the address of a specific receiver. Instead, one copy is sent to the group address, also called the multicast address (defined later as Internet class D address). This represents a major advantage for network operations, as less data processing is required and lower traffic is transmitted over the sender-Internet link, which increases the network efficiency and makes it more suitable for time critical applications.

The multicasting address scheme for group communication started with the work of Steve Deering of Xerox PARC when he developed multicast at the IP level. The class D Internet addresses (with first byte value between 224 and 239) are used for Internet IP multicasting. A small subset of this class (which include the range 224.2.*.*) are reserved for multimedia conferencing. It is this subset which constitutes the MBONE.

The multicast addresses are not physical permanent addresses, specific to a particular network interface or physical site. They are dynamic, existing only as long as a group of hosts are interested in sending and receiving multicast packets. Each multicast packet has a TTL value associated with it. TTL specifies how far a multicast packet should travel and how many mrouter it should cross in order to reach its destination. TTL also limits the distribution of a session i.e. from local distribution with a TTL value of 16 or less to worldwide distribution of up to 127).

Tunneling:

Tunneling is the scheme which was widely used to forward multicast packets between the islands of MBONE through unicast routers which cannot handle multicast packets. This is done by encapsulating, or hiding the multicast packet into a regular unicast packet and sending it over the Net to the appropriate destination. This tunneling method is called the IP-in-IP encapsulation.

To form a tunnel, a host or a client, puts the multicast packet on the network. The packet is then picked up by the local mrouter. The latter encapsulates the multicast information inside a standard unicast TCP/IP. This is done by placing the original multicast packet into the data part of a normal IP packet addressed to the destination mrouter, and then sending it to the intervening routers and subnets. The receiving mrouter at the other end of the tunnel, then strips off the encapsulation and forwards the packet appropriately.

The described process allows portions of the network which do not support multicasting to interconnect themselves across the portions of the network that support multicast. The set of all interconnected tunnels across the Internet form the MBONE.

As commercial mrouter and systems able to handle multicasting become more available, specially dedicated mrouter and tunnels will no longer be needed.

Figure 2.9 illustrates the IP-in-IP encapsulation tunneling method described above.

Fig 2.9: virtual multicast point-to-point link using IP-in-IP encapsulation tunneling.

Using this method of tunneling, the overhead required for forwarding the multicast information is kept at an optimal value which reduces costs of real time communication.

MBONE protocols:

In addition to the IP multicast protocol, the MBONE uses UDP (User Datagram Protocol), RTP (Real Time Protocol), and IGMP (the Internet Group Management Protocol) protocols, along with other encoding and data compression protocols. All traffic in MBONE uses UDP rather than TCP. TCP provides a point-to-point connection-oriented reliable byte stream protocol. UDP, on the other hand, is just a transport-level envelope around an IP packet with almost no control. One of the reasons why TCP is not suitable for multicasting is its reliability and flow control mechanism.. Occasional loss of audio packets, for instance, when using UDP during an interactive session, are acceptable. The delay of retransmission on the other hand(same as when using TCP) is not. One problem with UDP is that UDP packets may be duplicated and reordered, and may be also lost when transmitted over the Internet, which might reduce the quality of services to the end user.

On top of UDP and IP multicasting protocols, the MBONE applications use the RTP, a protocol developed by The Audio Video Transport Working Group within the IETF. RTP allows the multicasting information and applications to overcome the network latencies and errors and to achieve continuous playback of audio and video streams. Each RTP packet is stamped with timing and sequencing information with appropriate buffering at the receiving hosts. As a result, participants can still perceive conversations, as if they are in real time, while actually a small buffering delay has synchronized and sequenced the arriving packets.

Because the video and digital data are generated in very large quantities, and they eat up a lot of bandwidth, they need to be compressed in order to be transported more efficiently over the network. Some of the techniques used to do so include the Joint Photographic Experts Group (JPEG), and the ISO standard

H.261 for video. For audio, encoding includes Pulse Code Modulation (PCM) and Group Special Mobile (GSM).

IGMP is the protocol used to inform routers about the other directly attached members on their subnetwork. An IP host uses IGMP to keep the neighboring multicast routers informed about the multicast groups to which it belongs, by sending group membership updates. In return the end-host sends IGMP membership reports and send them to the destination multicast group. When a site wants to join a session, it sends an IGMP query message to the multicast group address to become a member of the conference. The site then starts receiving and sending multicast data. It is only those sites which expressed an interest (by sending the IGMP join message) which can receive any information addressed to that multicast group. In order to send information to that group however, the host does not have to be a member of the group. These packets can be sent through different routing mechanisms. The most popular protocol, which is also a standard is the Distance Vector Multicasting Routing Protocol (DVMRP).

Applications:

The main applications available over the MBONE today, are video and audio conferencing and shared whiteboard. Several software packages are available with these applications are available over the network which use multicasting to support multi-party communication.

Conference control tools:

Every MBONE session needs to be reserved and announced, in order to be further sent to interested participants. To do so, a conference control tool is required. The following section describes some of these MBONE Rendezvous tools.

SD : Session Directory :

SD is used by MBONE users to reserve and allocate media channels, which can be joined by other users. A typical MBONE session starts with the conference control tool SD. The session directory produces a window showing sessions announcements from all over the Internet. Clicking on a session name gives information about the tools used, as well as its time and date. Each session has a TTL time to live number. A small number doesn't allow packets to travel far over the Internet.

SD allows users to participate and to create their own session. If a session is chosen, the SD tool immediately launches the associated multimedia applications for the selected session. It can be described as a fully distributed Internet TV guide for creating, reserving and managing the global MBONE

multimedia channels or sessions. It's a very sophisticated and powerful package, in terms of its different capabilities of managing and allocating the MBONE multicast addresses among the different sessions.

SDR: Session Directory

SDR is the new version of SD and it includes several more advanced features and functionality than SD. These features include:

- A calendar of the scheduled events for the current and the two following months. This helps users to plan their sessions and to avoid conflicts with other sessions. Figure 2.10 illustrates an SDR calendar with day sessions being highlighting. Clicking on one day, the schedule of that day is displayed.

March							April							May						
Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Mon	Tue	Wed	Thurs	Fri	Sat
					1	2										1	2	3	4	
3	4	5	6	7	8	9	7	8	9	10	11	12	13	5	6	7	8	9	10	11
10	11	12	13	14	15	16	14	15	16	17	18	19	20	12	13	14	15	16	17	18
17	18	19	20	21	22	23	21	22	23	24	25	26	27	19	20	21	22	23	24	25
24	25	26	27	28	29	30	28	29	30					26	27	28	29	30	31	
31																				

Fig 2.10: SDR calendar window

Source: <http://www.cs.ndsu.nodak.edu/~tinguely/mbone-freebsd/mbone.html>

- The ability to link to Web browsers, like Netscape or Mosaic, and to download files and images from the Web. For a class setting, instructors as well as students can therefore support their presentations by quickly referrals and downloads of Web files.
- The ability to record events in case the user can't be present at time of broadcast. This feature is very helpful for students who miss a class lecture. The user, however, has to plan for plenty of disk space for audio, video and whiteboard data. This is sometimes difficult to predict since the different video encoding algorithms will most often send variations from one frame to another. Also, some users, especially students with low end computers, might not be able to provide the required amount of disk space.
- SDR also supports text, which is a new MBONE medium, through an application called mumble. Mumble supports textual conversations. Using mumble is similar to using IRC. The main advantage is that for a class session, for instance, students working on a group assignment can communicate in real time quietly, without disturbing other groups. This can also save huge amounts of bandwidth in case users decide that video is not required for their interaction.
- Last, and most important, the SDR provides the option of holding a public or private session. If a private session is chosen, it is only those who possess the correct encryption key who are able to join the session.

Figure 2.11 illustrates the SDR window with the different information about the chosen session..

Fig 2.11: The SDR information window

Source: <http://www.cs.ndsu.nodak.edu/~tinguely/mbone-freebsd/mbone.html>

MCC: Multimedia Conference Control:

Multimedia Conference Control, or MCC, is another session control tool available for MBONE users, which allows multi-party conferencing. Unlike the passive strategy of SD where the session provider waits for participants to join in, MCC explicitly invites others to participate in a conference. MCC allows for confidential sessions by using encryption keys. This limits access to only those having access to the same password. This feature is very practical and very important for telelearning, where access can be limited only to class members.

Real time Video tools:

Traditionally, video applications used to be created, saved and later downloaded for use. Today however, with the convergence of real time communication, the need for live visual interaction is becoming very important. Fortunately, more sophisticated networks are making real time video interaction easy and cheap. Unlike the traditional video-conferences, less equipment and bandwidth is required which opens access to the larger community of Internet users, especially on-line distance learners.

The following section describes some of the available software which enable real time delivery of video over the MBONE.

NV: NetVideo:

NV is the most popular MBONE video conference tool, which allows participants to send and receive live video over the Internet. NV produces a smooth video texture even during fast moving objects. Like most other MBONE tools, NV can be used for unicast point-to-point connections as well as for multi-party communication.

NV uses a new video compression algorithm designed to achieve low data rates and high frame rates. It also, uses RTP version 1 as the underlying application for video streams exchanges across the network.

Unlike when receiving video, a video grabber card is needed when sending video for systems with audio and video capabilities. Systems having imbuilt audio and video capability do not need one sending a video stream. To send video, a camera and video capture device is also required.

Figure 2.12 illustrates an NV video display.

Fig 2.12: NV main window

Source : <http://www.cs.ndsu.nodak.edu/~tinguely/mbone-freebsd/mbone.html>

VIC: VideoConference:

VIC is also primarily intended for multi-party video-conference, even though it can be run point-to-point using standard multicasting. Its main advantage over NV, is its use of the H.261 video compression scheme, which provides a higher compression gain. Much more CPU, however is required in order to be able to compress an H.261 stream, and unless a very powerful machine is used, a lower frame rate is produced with VIC than with NV.

Another advantage is that VIC was designed with a flexible and extensible architecture to support the different configurations. It is also based on RTP version 2, which is entirely implemented within VIC and therefore no special system enhancements are required.

One other interesting feature about VIC is its voice-activated switching. This means that a viewing window can be configured to follow the speaker. Using cues from the audio conferencing tool, VIC switches the viewer window to whichever source is speaking. This feature is very helpful for multi-party communication, such as in on-line lectures, where students can't have multiple windows on their monitors. VIC also has a built in data rate control which helps in preventing problems of accidental use of high data rate video feeds with large TTL video.

There are other video tools which are used for video-conferencing, but most of them are still at their development or experimental stage.

Real time Audio tools:

Audio can be used either as a support to a video-conference or as a stand alone means of real time communication. Even when used alone, audio provides a big support to real time conversations, since it allows users to express themselves easier than during textual conversations. Moreover, audio streams do not use as much bandwidth as video, which represents a very important advantage for users with low bandwidth connections.

The following section describes some of the commonly used real-time audio MBONE tools.

Visual Audio Tool: VAT

Vat is the most commonly used real time audio tool, and is the smoothest tool for audio-conferencing over the MBONE. Vat enables both host-to-host and multi-host audio conferencing. It can, also, use a variety of data compression format, allowing it to interoperate with several platforms and programs. Unlike the traditional phone based audio-conference, vat enables users to view who is speaking by displaying the identity of all those who are tuned in to the session, while highlighting the speaker's identity.

One other main feature of this tool, is the easy archival of audio-conferences into the personal information systems. In case of telelearning, this can be of great help for students if they need later access to class conversations.

One other important feature is that it provides users with a privacy/secretcy option using passwords. Access, therefore, can be limited and data can be protected, which is a very basic requirement for on-line lectures.

Vat, however, has one limitation. It uses half duplex data transmission. This means that only one participant can speak at a time. After finishing speaking, the user should shut off the microphone should in order to allow other participants to speak. In multi-party conversations, such as during on-line class sessions, interaction could be impeded if a user forgets to shut off his/her microphone. Also, students would have to wait until the instructor finishes speaking in order to be able to ask questions or to give comments. Using vat therefore requires users to be prudent in order to avoid accidental transmissions during a conference, which can be disorienting and disturbing. Also, this problem can limit the efficiency of live

interaction where spontaneity and quick comments are valuable. Fortunately, developers have lately upgraded the tools to full duplex, where participants can use a headset instead of speakers, which has significantly increased flexibility and easiness when using Vat. Figure 2.13 illustrates a VAT session:

Fig 2.13: Sample session with vat

Source: <http://www.serpentine.com/~bos/tech/mbone/apps.html>

Network Voice terminal: NetVot:

NetVot is another real time multi-party audio-conferencing tool over the MBONE. It can be used with stand-alone software or in conjunction with the SD tool, for point-to-point or IP multicast-based multipoint conversations, and it supports a wide variety of audio protocols.

NetVot has very similar features to Vat. However, it requires a special program called PMM, in order to be started. NetVot can use either the audio protocol Vat or RTP. The Vat protocol allows users to interact with others who may not be using the NetVot tool

Collaboration tools:

Collaboration tools, as their name indicates, provide support for real time interactions. These can be very useful within a telelearning setting, as they can be used as a blackboard in conventional face-to-face classes, for scribbling and as overhead projectors for slide presentations. Also, students can use them during their group work for group brainstorming and for working on a common document. The main advantage of

collaboration tools is that most of them require low bandwidth. The following paragraphs describe some of the collaboration tools used over the MBONE.

Whiteboard: WB

WB creates a shared, virtual whiteboard space for conference participants to exchange and share documents, display slides, write comments, draw and type annotations. In general, WB is mainly used as a visual aid for presentations and brainstorming sessions. It allows users to import slides in PostScript or text formats, to be viewed by all other participants. It is a very powerful tool if used in conjunction with real time audio tool. This is a very useful and practical option, especially for users with low bandwidth access, as in the case of most telelearners.

Unlike the audio and video tools, the data rate achieved by WB is low. WB does not use the RTP protocol for transmitting data, but it uses its own similar protocol called WB protocol.

It is important to note, though, that the session control is loose. This means that any participant can control the shared session, which increases the risk of unwanted interactions. In order to prevent such problems, sessions can be started in lecture mode, where only one user can have control over the session. This, therefore prevents miscreants from interfering in the session, and keeps their interactions invisible. In an on-line lecture, it is the instructor who controls the shared area. DES-based encryption is another security measure that WB uses in order to restrict the use of the shared whiteboard to a limited number of persons who are able to decrypt the transmitted data, for further use.

Image Multicaster client: IMM

IMM is another example of low bandwidth collaboration applications. It uses the client/server technology, where the server multicasts graphic images over the MBONE, the client then receives and displays them on the user's computer screen.

Shared Mosaic:

Shared Mosaic is an extension of the NCSA's WWW Browser Mosaic. Using the What I See Is What You See(WISIWYS)collaborations, participants can share a set of URLs at the same time. One main problem, though, is that sessions are loosely controlled. This can cause many problems during multi-party communication since anyone can decide to share a URL at any given time. To solve this problem, informal session control via live audio and video tools, such as VAT and NV, can be used during a shared Mosaic session.

MBONE VCR:

MBONE VCR which is a session recorder. It is used to record, playback, and randomly access any MBONE session. Like the MBONE VCR, most of the other tools used to playback MBONE sessions try to synchronize different media and use RTP protocol

MBONE requirements:

The MBONE is a network with routers supporting multicasting. In order to send and receive multicast packets, a user's local area network should have the appropriate hardware and software multicast support.

Hardware:

- To receive MBONE events, a multimedia computer with an Internet connection is required. Multimedia computers consist of a color display, an audio/video digitizer card, a video camera, a microphone, speakers and the MBONE software.
- To send just audio, a user needs a microphone and sound hardware. Sound hardware is already available in most UNIX workstations and Mac's. For PC's it is possible to buy a cheap sound hardware such as the Sound Blaster card.
- To send video, a user needs extra equipment, which include a frame grabber card and a camera in addition to the sound hardware.
- To receive the MBONE traffic, the computer platform should be able to handle multicast packets. Fortunately, today, most of the low end computer systems can process multicast packets.
- One extra requirement is the ability to rout multicast packets form one network to another. At this time, the Internet is being upgraded by introducing more commercial mrouters. For networks lacking these mrouters, a workstation can be configured as an mrouter with a running program called the mrouted (multicast routing daemon) to rout the packets to and from the hosts on the local area network.

Data traffic and Network bandwidth:

At present, the allocated bandwidth for the MBONE is about 500 Kbps. The video streams are also limited to 128 Kbps. Many users, however, try to limit their bandwidth by using lower bandwidth audio/video encoding schemes or by limiting their frame rate.

Application data traffic: The application data of the MBONE consists of, audio data, video data, graphics, and text files.

Audio data: The range of bandwidth required for audio data is between 68 and 78 Kbps. The audio applications available over the MBONE implement software compression for reduced data rates, as well as the Adaptive Pulse Code Modulation(ADPCM), The General Special Mobile(GSM)and Linear Predictive coding(LPC). All are methods of transmitting compressed data while maintaining a high audio quality. The audio traffic has the highest priority over the other MBONE traffic, because of the human low tolerance to audio loss.

Video data: the usual video data rates generated over the MBONE is about 125-128 Kbps. Higher data rates can be used within a local network. The compression, decompression and display of the digital video frames are all done in the software. NV produces between 25 Kbps and 120 Kbps at roughly 1-15 frames per second. VIC, however, is more effective than NV, as it is using the H.261 compression scheme which allows for more effective compression. Video data has the lowest priority compared with other MBONE traffic.

Graphics and text data: This type of data uses up much smaller bandwidth than audio and video applications(in the range of 5-6 Kbps). Peak data rates are achieved when a file is loaded and transmitted for sharing. The rate of interaction during discussions however is only around 1-2 Kbps or less. Graphics and text data have a medium priority when transmitted in conjunction with other data traffic.

Network bandwidth: In order to prevent the problem of receiving the whole MBONE traffic, an MBONE user should run a version of the multicast routing software that supports pruning. When a multicast routing software supports pruning, it only receives the required traffic. Pruning, however, should be also supported by the feed. If not, the receiver will still receive the whole MBONE traffic. The same problem results also, if a transmitter feeds a site which does not support pruning. The site would ask for the whole MBONE traffic, causing the transmitter's site to receive it also.

In order to fully participate in an MBONE session, a minimum link to a T-1(1.5 Mbps) is required. Full participation means: the ability to create any number of simultaneous session and to join any number of existing events, while using the maximum number of possible media.

Lower speed connections, such as ISDN connections can allow users to receive MBONE traffic. The main advantage of the ISDN is that it offers high bandwidth at lower costs. The main condition to receive bandwidth on low speed lines is that both transmitters and receivers should support pruning.

Next, if the bandwidth of the total event is within the limits of the ISDN line, a user can receive the total event. This can be the case of an audio-conference with/without the use of collaboration tools such as the whiteboard or IMM .

Another way to participate in MBONE events, is when the event is provided as many separate events: one for video, one for audio and one for whiteboard. The user therefore, can select one or more versions of the same event to join a session depending on the connection he/she has.

For an individual user, such as a student, the hardware and connectivity requirements for using the MBONE are much higher than what most of the Internet users currently have, in addition to their high costs. This is why, today, audio and text-based conferences are the more common than video-conferences. This implies that it will take time until live on-line courses over the MBONE can be easily held over the Internet. On-line courses between educational institutions(i.e. not between remote individuals), is possible today and many trials have been successfully realized such as the Jason project described earlier.

MBONE feed:

If an ISP or an organization wants to join the MBONE, it has to have an MBONE feed. Individual users on the other hand, can have the feed through their ISP. The organization, or the ISP needs to send a request to the MBONE e-mail list. The participants at close nodes cooperate in setting up ends to the appropriate MBONE tunnels.

Issues and opportunities;

Bandwidth:

- Some MBONE applications require high bandwidth access. This restricts its use to only sites which afford connectivity to high bandwidth links such as T1. By way of illustration, a multicast video stream of 1 to 4 frames per second eats about 128 Kbps of bandwidth(the stream uses the same bandwidth whether it is received by one or multiple hosts). This problem, however, does not restrict participation in MBONE sessions, as discussed earlier, especially if pruning in the sending and receiving sites is supported and if events are created in different data formats.
- Bandwidth is a scarce resources. Sending simultaneous high-bandwidth video streams, therefore, can easily saturate the network, causing congestion and interruptions of the sessions. Moreover, the limit of MBONE traffic today is 500 Kbps, which is not enough for running several simultaneous video-conferences. At full tilt, the MBONE can handle no more than four simultaneous video-conferencing

sessions or eight audio sessions. As the MBONE user community increases, the 500 Kbps limit will not be sufficient to handle the increased demand for bandwidth. The increased number of users not only increases conflict between events, but also increases the needs and requirements of MBONE users.

- Internet bandwidth is still inadequate in many countries. This would limit the use of the MBONE to only those who have the appropriate bandwidth and only those countries that have installed mrouters or workstations with mrouted software.
- The MBONE multimedia programming coupled with the power of the MBONE, resulted in an increased demand for bandwidth. This consequently, is limiting the use of MBONE for real time video-conferencing. Video for telelearning as discussed earlier under section 2.3: "Video-conferencing", significantly improves on-line lectures. Limiting the interaction to audio and text based communication can reduce the efficiency of the lecture sessions, especially when compared to conventional face-to-face lectures. To solve this problem either bandwidth needs to be available more cheaply, or better bandwidth compression methods have to be developed..

Because of the importance of these issues, researchers and developers have been working on solving these problems. Links between Canadian provinces for instance, which used to be limited to 56 Kbps, have been upgraded 20 Mbps ATM links. The United States is also using ATM links, multiple T-3 links, as well as fiber-optic links. In Europe and the US, ISDN connections are available for individuals at reasonable prices. Yet, this is not the case for the rest of the world.

Costs:

Despite the low cost of the required hardware, high bandwidth needs are very costly. High-speed connections to the Internet (T1 and higher speed links) can cost thousands of dollars a month. This might impede many individuals and organizations from running the MBONE. Nevertheless, the increased upgrades of links, and the increasing availability of high speed access will very likely lower high bandwidth costs.

MBONE management:

- There is no central authority to manage the MBONE. It is a self regulatory environment and is loosely managed by the MBONE users community from all over the world, in an open distributed way. Any developments and network or topology reengineering is therefore a group task performed via the MBONE mailing list, by several network engineers and developers spanned all over the world. The MBONE is jointly owned by the MBONE community. Preventing actions such as overuse, for instance, by dumping the network with very high bandwidth streams, is unfortunately, very difficult.

The fact that no charge is applied for the use of the medium, is likely to encourage the misutilization of the medium.

- The increased number of users joining the MBONE, together with the limited resource environment and the distributed MBONE structure, makes time management an increasingly difficult task in addition to the increasing risk of conflicts between sessions.

Misuse of tools:

- When using half duplex tools, such as some audio-conferencing tool, if one user forgets to turn off his/her microphone, other participants will not be able to talk since only one person can talk at a time. Such conflicts and problems are very likely to occur during lectures, where students are used to interrupt the lecture by raising hands and asking questions or speaking out. The video feedback from the student is not enough to interrupt and the audio feedback can not be heard by the lecturer. This can lower the efficiency of on-line lecture. In order to solve this problem extra training and coaching is needed for users before holding an MBONE conference, until new full duplex tools become more commonly available.

Network problems:

- Because of the networked feature of the MBONE, any mistake, such as blasting a high bandwidth video signal over 125 Kbps, can cause severe widespread network problem.
- Even though audio broadcast is supposed to be simpler than video broadcasts, preparation of an audio conference is as much time consuming as a video conference, mainly due to the inconvenience of the network monitoring tools.
- As the MBONE becomes more popular, it is very likely that more packets collisions and higher pressure on certain network slots would occur.

Most of these issues are in the progress of being solved, today, as the network is continuously being upgraded and improved.

Other issues:

- Even though MBONE users do not pay anything for using the MBONE, they do not get any guarantees of Quality Of Service (QOS). This is also called best effort service. This means that the system including the Internet service and the computer desktop of all the participants involved in the session, does the best it can to always deliver the MBONE service, but with no guarantees for quality.

New mechanisms and infrastructure, today, are being put in place for requesting and reserving bandwidth for as certain price. In order to limit overuse or misuse of network resources, users may be required to pay based on their use of the network resources and the QOS rendered by the MBONE.

- Real time traffic requires minimal delays between the transmitter and the receiver, and low packet loss rates. Right now, the Internet network protocols do not provide the needed support for real time service, and cannot ensure that real time traffic is transmitted with minimal delays and no loss of packets.

A new Internet protocol called the Internet Protocol next generation (IPng) or Internet protocol v6 (IPv6) is presenting big opportunities to partially solve this problem. The principles of this protocol have been already implemented and many sections of the Internet network have already made the transition from the IPv4 to IPv6. The main characteristics of this new protocol are:

- The ability to support multicasting.
- Effective high bandwidth and time critical traffic management: The new protocol can determine the different traffic priorities and needs, and puts this into consideration when routing data streams. Time dependent traffic therefore is quickly routed, as it is of higher priority than less time-dependent data streams.
- Assuring QOS by using the new Resource ReSerVation Protocol (RSVP) standard. RSVP is a new end-to-end inter-networking protocol which provides a means for networks to support special qualities of service for real time applications. The mission of RSVP is to allow routers to communicate among themselves and with end systems, so that they can reserve end-to-end network resources for time-critical applications.
- Authentication and encryption. These are provided in two ways: first, the IPv6 Authentication Header prevents unauthorized hosts from sending traffic to certain destinations, by forcing the sender to log into the receiver in a secure way. This extension leaves the specifics of the authentication algorithm up to the implementers, and helps eliminating a significant class of network "hacker" attacks.

Next, in order to prevent the interception of sensitive traffic, the IPv6 Encapsulating Security Header allows the IPv6 traffic exchanged between two hosts to be encrypted. Also algorithm-independent, its standard use of DES encryption will mean secure traffic even through the Internet.

- Video transmissions are not equivalent to the traditional video transmission (30 frames per second), the video MBONE transmission are at 4-5 frames per second. Which is considered to be slow by many users. In practice, however, this proved to be effective especially when combined with high phone quality voice.

- The tools used during MBONE sessions are still at the development stage and most network monitoring tools are inadequate.
- Lack of security: Controls on access to tools is primary and security is minimal. Also, there is still no common architecture for encryption or any other procedure to deal with security problems. With the expanded implementation of the IPv6, this problem will be soon solved. One of the already applied security measures is router filtering. As its name implies, routers filter out unwanted traffic, by acting as a firewall between one subnetwork and the rest of all the Internet network.
- Lack of technology standards can cause several communication problems. This problem also can be solved over time.

Advantages of the MBONE for a telelearning environment:

As discussed so far, the MBONE presents a big potential for the Internet. The multicasting capability coupled with the multimedia transmission of time-critical applications over the hostile environment of the Internet, strongly support the increasing convergence of visual information and live communication. As stated earlier under section 2.3 "Video-conferencing", studies have shown that live images, computer desktop-based voice and video conferencing technologies greatly enhance the effectiveness of on-line telelearning conferences. The free flow of opinions and ideas using voice, combined with the visual contact, greatly help preserving the human aspect of electronic remote interaction.

MBONE IP multicasting is a powerful tool in that it supports multiple party simultaneous access. The multicast traffic of the MBONE flows over the Internet IP routers, and is only directed to hosts interested in receiving the traffic. This Internet-based routing scheme allows for selecting participants, and limiting access to desired members, which is very suitable for on-line classes.

Furthermore, the MBONE uses the available bandwidth very efficiently which results in significant costs and time savings. Using the multicasting technique, a stream packet is able to reach all the desired destinations on several subnets without the need of being duplicated. The use of dedicated routers, separates the MBONE functions and therefore protecting other network communication such as e-mail and telnet from the MBONE different experiments. Moreover, as more protocols are developed, data encoding and compression will be more efficient which further increases the efficiency of using MBONE bandwidth.

Another interesting point about the MBONE, is that educational organizations will be able to significantly save on video-conferencing costs, and can be able to hold on-line classes, seminars, lectures and meetings

remotely, without incurring the exorbitant equipment, and facilities costs of traditional video-conferences. As mentioned earlier, MBONE hardware and software requirements are very basic and cheap. Once the software is downloaded, any MBONE user can reserve from their desktop an MBONE channel or session. Such sessions can be only received by the intended participants. The ongoing developments and enhancements of the network will make it more suitable for more secure transmission of multimedia traffic.

New technologies may soon provide individuals with T-1 speeds without the expense of an actual T-1 line. Among many other high speed access technologies such as ISDN, and cable modems, ADSL (Asymmetrical Digital Subscriber Line) will be also competing to provide home Internet access over existing copper lines at a rate of 1.544 megabits per second, and possibly at rates as fast as 6 megabits per second. It is important to note, however, that T-1 connection costs are very high in Canada compared with the states. This means that the MBONE can grow faster in the states than in Canada. Also, fast connections are easier to provide in North America and Western Europe, compared to other areas around the world. This consequently, might limit the MBONE benefits to only some parts of the globe.

For educational organizations which have been already using video-conferencing, using the MBONE will be very easily integrated for two main reasons:

First, these organizations have already their lines and equipment in place. An MBONE video-conference therefore, can be held at any time without making any special high bandwidth access arrangements. This can be very useful in case remote video-conferences are held between institutions, primarily in areas with limited access to conventional education resources. In order to attend lectures, students can meet at a single location and access their classes using workstations with MBONE connections.

Second, many companies and organizations today, are already increasing their bandwidth to include the Internet for a fast and 24-hour connection, by connecting their Local Area Networks (LANs) to T1 lines. Accordingly, extending the connection to include the MBONE will not be that expensive. Moreover, the services and convenience provided by the MBONE far outweigh its connection costs. The network traffic, though, should be always controlled and well managed, especially when establishing or participating in a full media MBONE session, since a busy network can impair the MBONE data flow.

Until broad bandwidth becomes commonly available and affordable to individuals in general, and telelearners in particular, using the MBONE to deliver distance education courses would be a very cost

effective solution, allowing academic institutions to save on equipment renewal, facility and equipment maintenance costs, as well as other traditional video-conferencing ongoing expenses.

Comparison of the Internet tools:

The following table compares the different tools with respect to several elements. In many cases it was difficult to provide a clear answer, as rapid technological developments are blurring the limits between the different tools. Moreover, several versions of some tools coexist, such as for MUDs and MOOs, each with different options and features, which added complexity and confusion to the categorization process.

Table I.1: Comparison of the Internet Asynchronous tools.

	E-mail	Mailing lists and Newsgroups	WWW conferencing
Conferencing type	Asynchronous	Asynchronous	Asynchronous/nearly synchronous
Multimedia options	Possible using a software and as attachments	Possible using multimedia attachments	Possible using hyperlinks and by integrating them in the message
Need for support	No	Sometimes	Sometimes mainly for first time users.
Maintenance and updating effort required	Minimal	Medium to low	Small
Maintenance and updating effort required by training organization	Minimal	Low when asynchronous, and high when synchronous.	Small
Time required for development	Very low	Low	High
Development costs	Very low	Very low	Medium/very low
Need for computer literacy by user	Very low	Very low	Very low
Cost for student	Very low	Very low	Very low to high*

* If the software is proprietary

Table I.2: Comparison of the Internet synchronous tools.

	MUDs, MOOs and IRC	Audio-conferencing tools	CUSeeMe	MBONE
Conferencing type	Asynchronous and synchronous	Synchronous	Synchronous	Synchronous
Multimedia options	Possible integration of audio, can be used with a video-conferencing software, VRML, and WWW multimedia file downloads	can be used with a text-based tool, and can use multimedia files using whiteboards.	Live audio and video with the option of using whiteboards for text and multimedia files	Live audio video with the option of using whiteboards for text and multimedia
Need for support	Sometimes	Sometimes, but frequently for first time users.	Sometimes/often depending on the amount of bandwidth available	Yes, mainly first time users and when joining the network.
Maintenance and updating effort required by the organization	Medium to high	Medium	Medium	Medium
Maintenance and updating effort required by student	Medium when asynchronous, high when synchronous	Medium	Medium	Medium
Time required for development	High	Minimum	Variable	Variable
Development costs	Very low	Very low	Medium/very low	Low
Need for computer literacy by user	Very low	Very low	Low	Low
Cost for student	Very low	Medium/high ¹	Very low to high ²	Low to high ³

1. Most of them are proprietary.
2. The Initial CUSeeMe version can be downloaded for free, while the new Version 3.0 of CUSeeMe, "Enhanced CUSeeMe" is being sold at this time for \$49.00, while upgrades cost \$29.00
3. Best MBONE real time video-conferences can be transmitted using expensive high speed Internet access options. Also, MBONE access costs are higher than the regular Internet access costs and may not be available from all ISPs.

4. CONCLUSION:

Despite the increasing popularity of the more sophisticated synchronous or real time Internet applications, benefits of the cheaper and more flexible asynchronous tools within a telelearning environment can not be denied. This is why in order to get full benefit of the Internet technology, an appropriate mix of both synchronous and asynchronous tools should be adopted.

Tools such as basic and multimedia e-mail, newsgroups, mailing lists and multimedia web conferencing are most appropriate for time delayed conversations, extended class discussions and teacher-student-anytime consultations. Also they are perfectly suitable in case of time zone problems where it is difficult for certain students to attend real time on-line classes because of time conflict, as well as in case of any other personal reasons. They are also a necessity for students who would need to consult pervious class sessions, lectures and class material and primarily for on-line research.

Real time conferencing tools, on the other hand, such as multimedia MUDs and MOOs as well as IRC would be very suitable for an effective simulation of face-to-face lectures, with the support of multimedia Web files. Audio-conferencing tools would be also effective for on-line multi-party conversations, particularly when used in conjunction with helper applications like a whiteboard as in case of presentations and group brainstorming. At the time of this writing, the video-conferencing tool CUSeeMe is used in Internet based telelearning, but it is mostly used for a small group of sites, despite the possibility of chaining reflectors to increase the number of participants. It is expected, however, that larger video-conferences would be held using this tool, as it prevails more among the students community. The MBONE technology, on the other hand, would be the most convenient alternative for effective real time conferencing in the near future, as more Internet Service Providers start offering the service at affordable rates and when low cost high bandwidth access becomes common almost all over the globe.

Part II:

CURRENT IMPLEMENTATIONS

**Chapter 3: Internet Distance Education Applications :
Classification and Case Examples**

Chapter 4: Survey Results And Analysis.

Chapter 5: Yahoo! Internet life. Survey Analysis.

INTRODUCTION:

Investigating the current practices and implementations of the Internet within a telelearning environment is very meaningful and useful, as it provides us with a better understanding of the real present state, vis-à-vis the different expectations and assumptions of how a cyber educational institution would perform its activities and undertake its responsibilities in a virtual setting. For this reason, this section about Current Implementations was included, with 3 different chapters examining the present situation from a different aspect.

In Chapter 3, a study of how the Internet is being deployed to support the different administrative and pedagogical functions of virtual and partially virtual educational institutions was provided. Then, some cases of virtual educational institutions which were already operating on-line were included. This chapter is in fact, a reproduction of the paper I published in the "Education at a distance" journal(1996)

Chapter 4 provides a summary of the results and the analysis of outcomes of a survey that I held in June 1996, aimed to the on-line educational community. The 10 questions comprised topics about the different aspects of the Internet medium, with the intention of collecting the maximum feedback about current implementations, besides the different impressions of those who have already experimented an Internet based telelearning environment.

In March 1997, Yahoo! Internet Life magazine held a survey to identify the most wired American schools and to examine how they are deploying the Internet to establish an on-line telelearning environment. Believing that this survey's results strongly related to our topic, a discussion and an analysis of these findings is presented in Chapter 5. Next, based on the outcomes of the three chapters, a general conclusion is added at the end of the section which summarizes all the findings.

Chapter 3:

Internet Distance Education Applications: Classification and Case Examples

3.1 Introduction:

The Internet is currently used for a broad range of educational applications, ranging from accessing reference material to delivering entire courses.

The objective of this paper is to identify and classify the full range of educational applications of the Internet and to give illustrative case examples of each classification. The classification is then used to analyze trends in the way which the Internet may be used for telelearning in the future.

The classification is divided into two parts:

- A categorization of the methods of instruction and leaving over the Internet;
- A categorization of the organizational structure of educational institutions.

3.2 Methods of teaching and learning:

3.2.1 classification of teaching/learning methods:

Delivery of course material:

Course material can be organized in the following formats:

- Print, audio and video tapes sent to the student with the initial contact between the student and the institution done through a web site.
- On-line manuals and textbooks hypertext and hypermedia formats
- Multi-User Dimension Environments (MUDs, MOOs, MUSEs, etc.) where the instructor and the administration staff can have real time communication with the student and provide him/her with the necessary information about the course requirements and administrative procedures.

In order to exploit Internet capability, libraries are digitizing their resources and making them available for the global community in a way which protects copyright. Teachers and students are archiving a wide range of information and materials to support the learning.

Class session:

Lecture:

The lecture can be either on demand (asynchronous) or real time (synchronous)

Asynchronous lecture: this is provided through:

- Web pages in hypertext format, with glossaries, indexes, exercises, and references to relevant material on the Internet, or on reserve in the institution's library which could be retrieved remotely.

- Hypermedia lectures and class discussions which could be retrieve when required.

Synchronous lecture: these can be held using different tools, such as :

- Internet Relay Chat, IRC
- MUD, MOO environments which are either only text based or with the option of integrating hypermedia files form the web.
- Other conferencing software such as Pueblo and Webchat which allow the incorporation of multimedia (audio and video), 3D scenes and graphics.
- CUSeeMe and Vosaic software which allow for real time audio and video over the Internet
- The emerging MBONE technology which allows multicasting and real time audio and video over the Internet with high quality voice and video.

Class discussions:

Real time class discussions are held through any of the following tools:

- Text-based conference software using IRCs, prearranged e-mail sessions, IRCs, MUDs and MOO environments.
- Real time audio and video using CUSeeMe, Vosaic , or the MBONE
- Listserv, newsgroups and e-mail especially if students need to discuss subjects with the global Internet community

Virtual office hours:

Support form the instructor can be provided in various ways such as :

- Web page, where students can get quick answers of some frequently asked questions,
- E-mail: which allows the student to discuss a problem or a question in real time, with the option of integrating relevant material in different formats (text, audio, video, 3D scenes, graphics)
- IRC or Mud sessions which allow the student to discuss a problem or a question in real time, with the option of integrating relevant material in different formats (text, audio, video, 3D scenes, graphics).

Assignments:

Because of the ability of downloading and uploading files via the Internet, students are able to send their assignments electronically via e-mail, or using special folders which can be only accessed by the instructor and the student.

Exams:

Students in institutions which take classes with other on campus students can take their exams in person in an examination center. Some institutions, mainly those which are entirely on-line, allow their students to take their exams via the Internet using real time conferencing software such as IRC, and MUDs.

We now give examples of the above five teaching methods. Many organizations are using the Internet for teaching. The case examples presented here are a selection to illustrate innovative approaches.

3.2.2 Teaching/learning Methods: Case Examples:

Delivery of course material:

At Athabasca University, on-line courses use the Web site as a repository for information about administrative registration procedures and the course study plan. Hypertext student manuals, lists of Internet resources and Internet tools are also provided in hypertext format which can be consulted when needed.

In a biocomputing course organized by the virtual school of /natural Sciences (VNSS), a member school affiliated with the Global Network Academy, (GNA), 5 authors from USA and Germany prepared a hypertext textbook. The hypertext book contained several links to different databank search services on the Internet. according to the instructors who designed the course, the hypertext book was very effective in integrating Internet resources with the course and in keeping information up to date.

At Indiana University-Purdue University at Indianapolis (IUPUI), students can access reserved material remotely. David Lewis, head of public services for university libraries stresses that Reserves on-line can deliver high quality images, assure document integrity and permitted simultaneous access by an entire class. Moreover he believes that the ability of having a special electronic collection on-line via the Internet, will allow fir an efficient and cost effective way of delivering necessary material on demand to several institutions. Students are also provided with references for research resources. These are, primarily, the collections of electronic libraries consisting of course related materials and the cross references provided in hypertext, supplemented by the wealth of on-line information available on the Internet, such as databases, newsgroups, listservs, mailing lists, etc.

Class session:

Lecture:

Some institutions, such as University of North Dakota (UND) deliver lecture material to students by mail, and use the Internet for posting summaries, and for real time discussions. Keeping the class sessions on-line, provides students with an extra information resource for future reference.

In a project developed by the Department of Mathematics and the Center for Information Technology Services, both located at the University of Oslo, lectures are designed using the Hypertext Markup Language (HTML). Students can navigate freely in the information available, by using different links available in the text. Video-lectures, graphics, exercises, and animated files can also be downloaded. According to many instructors, incorporating multimedia when teaching increases the ability to meet student's needs, and helps to accommodate their life styles and their assimilation rate.

Students from Peter Lalor Secondary collage, in Melbourne, met their counterparts in Singapore over the Internet and performed a range of experiments and discussions using Cornell's Multicast reflector CUSeeMe.

The University of Florida and Virginia Tech have used the MBONE to share the expertise of professors between the two institutions. The university of Florida used a conventional classroom with computer projection equipment. Virginia tech used a computer lab in which each student participated in the class using a Sun Workstation. Ham main advantage of this arrangement was that state of the art graduate topics can be taught by professors who are specialized in that field. Participation of more institutions further enhances this advantage.

The University Of British Columbia is planning to use the MBONE for delivery of 3rd and 4th year undergraduate courses in computer science to community colleges in Kamloops and Kelowna which are several hours drive form the main campus. The perceived advantages over the conventional video-conferencing are: the software and the communication are almost zero marginal cost, and there is no need to purchase conventional video-conferencing equipment at the receiving site since computer projection equipment is already installed in any classrooms and existing computer labs headphones for audio can be also used.

PBS plans to use the Internet multicast capability for a series of live video-conferences for colleges and universities. In addition to the multicast capability, software VDOnet incorporating RSVP, Resource ReSerVation Protocol, allows bandwidth to be reserved across the Internet to ensure jitter-free audio and video.

Class Discussions:

Many courses on-line are heavily based on group discussions and interaction between the students, especially in the absence of audio and video transmission. This is particularly true of graduate level courses. The role of the instructor, in this case is mainly to monitor the group and to direct and focus the discussion session.

At CyberHigh, a high school entirely resident on-line, students meet via the text based Internet Relay Chat, where students discuss problems and ideas related to the course subject. Because IRC multi-user and multi-channel feature, students can talk in a group as well as on a one to one basis. Usually on-line class sessions are transcribed and put on-line for further reference by students.

The Diversity University, which is an entirely on-line university uses a text-based MOO, with the option of adding a web window which offers the use of multimedia along with real time discussions. This can be realized by using a browser which supports programs such as Java , which can download and execute multimedia applications.

Some institutions use class listservs and USENET groups, for Internet wide discussions. Professor William, at Illinois State University, who has experimented with these tools in his seminar "Developing and Designing Computer Applications in Arts", states that Internet wide discussions provides valuable input and support for the students, and helps them in solving problems and critiquing their work. through prearranged e-mails and USENET group discussions, Professor William's students can share the talents and experience of experts, without the limitations of time and geography. After class discussions via synchronous Internet tools allow lengthy discussions and arguments which are not possible in a traditional classroom setting because of time limitations . Moreover, students are found to develop more collaborative and problem solving skills through such discussions.

Virtual office hours:

Instructors offering on-line courses also have office hours for students and assistance. After his on-line experiment with 10 on-campus students and 350 offsite subscribers at Pennsylvania University, James O'Donnell stated that he was able to "speak" with each student in his course via the Internet, something that would not have happened if all students were on campus in a lecture hall. E-mail, is judged to be very effective by instructors in providing the opportunity for students to ask questions at any time and to provide feedback and support.

In an experimental on-line course, which was offered at Purdue University, the instructor made himself available at scheduled times for e-mail, on-line talk sessions and conference calls.

As part of its new international "Master's Open and Distance Education" at the open University, which started in February 1997, students will be using an electronic workbook, which the tutor may ask to see, in which the students record their learning using notes and paragraphs. This allows the tutor to know where students are experiencing difficulties.

Assignments and team projects:

Assignments are mostly submitted electronically via e-mail. Students at Illinois State University, taking the course "Designing and Development of Computer Applications in arts", have private files to submit their assignments, which can be accessed only by the instructor and the file owner. The instructor has also created on-line files where students can share results of their work for critique and discussion. Feedback on an individual basis from the professor can be provided also through e-mail or real time chat sessions via the IRC, MUD or a MOO.

Working on projects on teams is also encouraged via the Internet to encourage interaction, team building and critical thinking among students. Diversity of group members and their backgrounds also adds value to the final work. A team of accounting students from the West Virginia University and Frostburg University has collaborated on a project to solve real world government problems. The team members on each campus designed web pages, where files from both sites were uploaded and downloaded for information. The students also used the World Wide Web resources during their research.

In some institutions such as IUPUI, students can be asked to write multimedia papers. Through the use of a special system called the Interactive Multimedia System, students can incorporate copy and paste video and

audio clips in their papers, save them and use them later for presentations or “hand them in” via e-mail to the instructor.

Professor Knoll of the University of Texas organizes international collaboration among masters students in MIS, each registered in their own university. Team work involves members from diverse cultural backgrounds, living in different time zones and provides experiences for future careers in virtual organizations in addition to being a means of conducting student project in MIS.

Exams:

The availability of real; time conferencing tools, has made the delivery of exams remote students possible. At Cyber School, students can take exams on-line via an IRC channel. One typical exam is where students are asked one question at a time, similar to oral exams, and are required to answer within a limited time.

“The University of North Dakota studies distance program” requires distant students to identify a proctor (a counselor, supervisor, librarian or other responsible individual), who is willing to administer the student examinations.

3.3 Organizational Structure:

The ability to access valuable information resources and to communicate using synchronous and asynchronous multimedia software brought with it new expectations, needs and demands for a more flexible education. In response to these challenges, new “virtual academic environments” have emerged, taking advantage of the new technologies and addressing one main objective: the timely delivery of a high quality, low cost instructional materials to a diverse range of students. These environments include virtual colleges, high schools, universities and on-line classes and programs , which allow people to take courses at their convenience.

These virtual academic environments fall into 3 types of organizational structure which are described in section 4.1 with case examples in section 4.2

3.3.1 Classification of organizations:

- Campus based institutions offering on-line courses and programs, as an extension to their regular offerings.

- Alliances of campus based colleges and universities, which provide an electronic interface to access different education classes.
- Independent organizations existing entirely on-line which have established their own academic departments and curricula.

3.3.2 Case examples:

Campus based institutions: Space studies distance degree at UND:

The University of North Dakota is currently offering a space studies masters degree both on campus and via the Internet, with the objective of meeting the needs of students wishing to enter this field or to expand their knowledge, and who have different life commitments that prevent them from attending classes on campus. By taking the course via the Internet, distant students are able to have the same opportunities for discussions and research as on campus students. Information, links and cross references to other materials pertaining to coursework are accessible on Internet web site. At the start of each term, students receive a package of textbooks, and lecture video tapes. Weekly real time discussions via Internet Relay chat, are scheduled in order to allow students to discuss and share ideas and ask . The instructor acts as moderator, by controlling and coordinating the pace of and content of the discussions. Transcripts of previous chat sessions are then kept on-line for students to use further reference. During the summer, distance learning students attend a 2 week workshop, in order to apply and integrate the knowledge acquired during the year.

Alliances of campus based institutions: California State University Network, CSUNet:

CSUNet is the computer network of the California State University system. CSUNet interconnects California State campuses as well as other “partner” sites like local community colleges, and school district offices within California. The main objective of CSUNet is to provide access to all publicly accessible Internet sites around the world, in addition to a number of other services such as delivery of courses among the “partner” sites.

Institutions existing entirely on-line: Virtual on-line University: VOU

The virtual On-line University Inc. is a non profit organization established and incorporated in 1994 in Missouri with the intent of providing high quality and low cost educational opportunities to a diverse group of geographically dispersed students and to assist traditional and non traditional students in achieving their educational objectives. Currently the VOU is offering 16 courses with transfer credits, taught by professors from six different universities.

The VOU is operating within a Virtual Education Environment (VEE), which is a multi user Object Oriented (MOO) based electronic campus. Students who access the VEE, can have a virtual tour in the

university departments office and classes, by typing word commands. Recently, VOU has upgraded its VEE by including an Internet client called Pueblo, which allows instructors to have access to any material on the World Wide Web and to incorporate multimedia in their class sessions. An instructor can share images and 3D graphics, download video audio clips and give hypertext quizzes and exams, while holding discussions on a text based chat.

3.4 Conclusion:

3.4.1 Teaching and learning Trends:

The Internet today is continuously adding advances and developments in the field of distance education. New emerging Internet technologies and powerful tools such as the MBONE, Virtual Reality Modeling Language (VRML), Multimedia languages (such as Java), MUDs, MUSEs and MOO environments, and the World Wide Web itself, allow students in the world wide community to complete courses electronically without ever having set foot in a classroom.

There are two main trends taking place. The first is the evolution from text based tools (such as IRCs to off-line multimedia (such as retrieving audio/video files at Web sites) to real time multimedia (such as CUSeeMe and MBONE conferences). Each stage in this evolution requires increased performance from the Internet. As Internet bandwidth is upgraded and technologies such as RSVP are developed to reserve bandwidth, the quality of communication becomes acceptable to an increasingly broad range of educational applications.

The second major trend is the increasing sophistication of the Internet's multicast capability which is essential for educating multiple students. The evolution from USENET group to reflectors to IP-multicast provides an increasingly flexible and efficient form of multicast for educators.

These trends enable educators to use the Internet not just for delivering course materials, receiving assignments and exams, but also lectures, class discussions and virtual office hours.

3.4.2 Organizational trends:

An institution like VOU presents a typical prototype of future universities. Its main strength is in the incorporation of emerging technologies, and its ability to accommodate the different needs of a wide and diversified group of students regardless of time and place.

Until recently, close proximity has been a primary consideration for students, a particularly working adults. With the proliferation of on-line courses, location will no longer be the primary criteria for choosing a college program. Instead the course content and organizational flexibility become the deciding factors.

Chapter 4:

SURVEY RESULTS AND ANALYSIS

4.1 Introduction:

Against this background about the Internet tools and technologies, their use and applications for telelearning, along with the increased availability of on-line courses and universities over the net, I decided to hold a survey to evaluate the use of the Internet tools and technologies for the development and delivery of education/training. The survey does not take into consideration those telelearning practitioners who did not have an Internet connection when the survey was held, but they were interested to integrate it into their curricula during the 1996-1997 school year, since the survey was held through a mailing list.

The Distance Education On-line Symposium mailing list (DEOS-L) provided an appropriate sample of telelearning practitioners via the Internet (mainly instructors and staff members), as well as The Global Network Academy (GNA) instructors. The survey design was patterned after the book "Survey Research Methods." by Babbie(1990), and includes 10 short questions. A sample of the survey questions is available in Appendix A.

Section 4.2 provides a description of the survey details, its structure and basic information about respondents. The following sections, i.e. sections 4.3 to 4.9, starts by giving the reasons for asking the question, followed by some hypotheses about the expected results, which were formulate based on the information obtained when researching the topic before holding the survey. Next, the survey results are summarized and are complemented by graphs portraying each set of results. Finally, the conclusion in section 4.10, provides an overall summary of all the survey results.

4.2 Survey details:

The survey was posted on the 24th of June 1996 on the Distance Education On-line Symposium mailing list (DEOS-L). Another sample of the survey was sent via e-mail to the Global Network Academy president Joseph Chen-Yu Yang, who had posted it on the GNA instructors internal mailing list. The GNA mailing list involves about 30 instructors.

The DEOS-L is a service provided to the distance education community, by the American Center for the Study of Distance Education. This mailing list included about 1423 subscribers as of June 1996.

The survey included 10 short answer questions: 8 questions with short multiple choice answers, to save respondents thinking about wording their answers (which could have been discouraging for them to reply, and two questions which requested respondents to write short answers about their personal opinions with regards to using the Internet for telelearning.

The first two questions were asked to get information about the user's function and type of institution. The six following multiple choice questions, investigated the degree of using the Internet, the tools used and any future plans for implementing any extra tools. The two last question required respondents to give their personal opinions about the advantages and issues of using the Internet within a telelearning environment.

The survey produced 114 responses, where 8 responses were from the GNA mailing list, and the other 106 were from the DEOS-L list. This number of received responses represents a 7.84% response rate. The following table elucidates better these outcomes:

Table 4.1: response rate by mailing list

	Number of mailing list participants	Number of responses	Response rate (%)
GNA mailing list	30	8	26.66%
DEOS-L mailing list	1423	106	7.44%
Total	1453	114	7.84%

All replies were received by E-mail. The reply time varied between 24 hours and one month, depending on the availability of the respondent. Most respondents however, responded within a week.

As shown bellow in the chart of Figure 4.1, 53% are faculty members or instructors. The "other " category includes mainly students, educational consultants, assistants, and staff members. The following statistics were obtained from the results of questions 1 and 2.

Fig 4.1 :Respondents function

Nearly two thirds of the respondents' institutions of the telelearning practitioners via the Internet are universities. This reflects that these institutions have easier access to computer facilities than colleges, primary and high schools.

Fig 4.2 : Type of institutions (question 2)

4.3 Internet use for distance learning:

Interestingly, nearly all the respondents 91%, were already using the Internet in one form or another for telelearning. Among the 10 respondents who did not integrate yet the Internet in their teaching, 8 are planning to use it during the current school year (1996-1997).

Fig 4.3 : Percentage of respondents who were using the Internet tools in 1995-1996 versus those who didn't (question 3)

4.4 Question 5: Reasons For Using The Internet:

By asking this question, we wanted to know the reasons which have encouraged telelearning practitioners to integrate the Internet in their courses.

Based on the information obtained while searching about telelearning via the Internet, some of the main reasons of using the Internet for delivering the educational material include:

- Making communication easier between students and instructors.
- Allowing students with different needs to learn in the convenience of their home or office, without wasting time in traveling to campuses.

- Allowing students to take courses and earn degrees on a flexible schedule that is most appropriate and convenient for them.
- Allowing instructors and students to interact remotely with remote experts, and to work with other students from different parts around the world.
- Providing students with a powerful research tool, with extensive amount of valuable information, resulting in better quality and more up to date information.

The asynchronous communication nature of various Internet tools, such as the Electronic mail, listservs, mailing lists, newsgroups and bulletin boards, is a powerful feature in providing this service.

Moreover, the ability to post, send and access huge information resources at very cheap prices makes the use of the Internet more cost effective than the traditional way of delivering educational and training material.

Survey results:

In order to answer this question, respondents were given 7 suggestions, including an other option where they can add any extra reasons. The following results were obtained:

74% of respondents agreed that their main reason for using the Internet is the ability to access and to reach students anywhere and anytime at the convenience of every participant. Another majority added that another reason is that the Internet improves communication between the different class members which results in further advantages as will be mentioned in the ninth question.

In addition to the above mentioned reasons, answers included other reasons such as: (the number of answers are indicated between parentheses):

- It allows cooperative team learning and creates a more active learning environment (11)
- It is cost effective since most of the material is on-line (2)
- It's fun and entertaining! (2)
- It helps students become familiar with Internet tools and technologies.(7)
- It helps students to develop many necessary skills such as writing and discussion skills. (7)
- It is easier to teach Internet classes.(3)
- It is flexible (8)
- It provides a wealth of information (3)
- It provides students and instructors with up to date information (3)

- It is inexorable; therefore, instructors have a professional obligation to make the best learning with it that they possibly can. (1)

A general comment about these answers is that most respondents agreed on most of the suggested reasons for using the Internet.

Figure 4.4 illustrates the responses to each suggested reason

Fig 4.4: Reasons for using the Internet for telelearning

4.5 Question 6: Internet Tools And Technologies Used:

The Internet offers several tools, some are very widely used such e-mail and newsgroups, others are less popular such as MOOs and Web conferencing, while others are still at the trial stage and are limited to some experimental sites such CUSeeMe and the MBONE. Because of all these options, we wanted to know what tools respondents were using during 1995-1996 school year, and what tools they were planning to use this year i.e. 1996-1997 school year.

Tools such as e-mail, Listservs, mailing lists, newsgroups are widely used by Internet users, especially for instructor/student and student/student asynchronous communication. They are relatively low cost, demand only modest bandwidth on the part of the user. Moreover, most institutions having an Internet access are providing these services to their students, and many professors are finding it very convenient to flexibly communicate with students.

Such tools also allow students to read postings from the instructor or other students at leisure and respond at convenient pace and communicate directly and privately by e-mail with the instructor or any other student.

Moreover, newsgroups and mailing lists are in many cases valuable information resources for students when working on research project. Private mailing lists or listservs, restricted only to class members allow instructors to post their material for students use, saving consequently on paper and other delivery media costs.

Based on these facts, the following hypothesis can be stated to be validated later with the respondents' replies:

Hypothesis 1:

E-mail and its applications are the most widely used for on-line delivery of lectures and class discussions.

The Web plays a powerful role in delivering information with the integration of graphics, page formatting, text, audio and video. It does not, however, provide currently a real time Web conferencing tool. Even though proprietary chat tools are increasing in popularity, their costs and lack of standards are discouraging many telelearning practitioners from deploying them for class members communication.

The Internet, nevertheless, does provide two important low bandwidth tools , which allow for real time text based communication. The first tool is the IRC and the second includes a variety of environments depending on the programming language used for interaction. The two commonly used environments are MUDs (Multi User Dimensions) and MOOs (MUD- Object Oriented).

When researching the topic through the Internet, real time conferencing tools, especially MUDs and MOOs, seemed to be increasing in popularity among the educational community. Several institutions have been already using these tools for on-line course delivery. Moreover, the increased developments in this technology are providing users with easier user interfaces and more flexible virtual environments. These two factors can, to a large extent, encourage more institutions and instructors to integrate these tools in their on-line lectures.

Based on the above mentioned facts, the following hypothesis can be formulated :

Hypothesis 2:

The growth rate of adoption of the Internet text based conferencing tools including MUDs, MOOs and IRC is higher than that of the WWW and e-mail applications, during the academic years 1995-1996 and 1996-1997.

Hypothesis 3:

The use of MUDs and MOOs within the telelearning environment is expanding at a faster growth rate than IRC.

Despite the availability of some real time audio and video tools such as Real audio and VDOnet, their immature technology and high bandwidth requirements, it is unlikely that the telelearning community uses these tools for their on-line course delivery. Even when institutions have access to high bandwidth connections, network problems such as congestion and slow connections and associated costs, restrains these institutions to low bandwidth applications.

The recent enhancements in the Internet video-conferencing tool CUSeeMe and its bandwidth efficient reflector technology, are promising cost effective real time video-conferences. This tool, however, still requires higher bandwidth than that of modems, for higher quality video transmission. This requirement is still difficult for many student with limited budgets.

Based on the provided information over the Internet, several institutions are experimenting the tool for their on-line course delivery, and will be soon integrating it a part of their program. Overall, unless networks technologies and bandwidth are upgraded, and costs of technologies and network scarce resources are moderated, telelearning practitioners are very unlikely to adopt these tools, at least the time when the questionnaire was sent, for on-line material delivery.

Hypothesis 4:

The growth rate of CUSeeMe for the academic year 1996-1997 is:

- a) Higher than that of 1995-1996, but*
- b) It is much lower than he growth rate of text based conferencing tools.*

When it comes to the MBONE technology, even though it is the most convenient and cost effective application for the telelearning environment, its high bandwidth requirements (minimum T1), is restricting its use to those who afford this type of high speed connections. Even though the technology has been used by several institutions for telelearning purposes, chances are that nearly none of the respondents are experimenting the MBONE.

Survey results:

As shown in the graph below, compared with other tools, e-mail is the most popular tool and is nearly used by all the respondents (95%), while the remaining 5% were planning to integrate during 1996-1997 school year. This confirms the fact it is the tool's affordable costs, in addition to its asynchronous feature and the related benefits which promoted the quick adoption of the tool, within the telelearning community. Since it is almost universally used, its growth rate is lower than any other Internet tool.

E-mail applications, such as newsgroups, mailing lists and listservs, are remarkably, less prevalent than the elementary e-mail application. This is conceivably, because of the complex and time consuming maintenance and update requirements of these tools. Their use however is expanding, with the newsgroups having the highest growth rate. This is presumably, due to the new trend of conferring openly with the larger Internet community, primarily, other students, and experts.

The second most used tool is the World Wide Web, which is already used by 81% of the respondents. The remaining 19% were planning to use integrate it in 1996-1997. For this reason the WWW growth is the second lowest after, e-mail.

Many of the Web's benefits and capabilities, such as its accessibility, its considerable information resources, and its flexible hyperlinked environment, are definitely the main justifications behind its wide prevalence. These rationale is also confirmed by the answers of question 5, where 50% of the respondents consider using the Internet as cost effective, and 32% are of the opinion that that it makes student research easier.

These results partially confirm hypothesis one, since e-mail is indeed the most common tool in the telelearning environment, except that it is the WWW and not the other e-mail applications, which is nearly as predominant as e-mail within the telelearning environment, as illustrated in the chart in Figure 4.5.

Fig 4.5 : Percentage of 1995-1996 users and 1996-1997 additional users for each Internet tool

Fig 4.6: Growth rate of each Internet tool during the academic year 1996-1997

As delineated in the chart of the number of respondents (Fig 4.6), those who have already integrated text based conferencing tools is unexpectedly very low (only 4% are using MUDs, 9% are using MOOs and 11 % are using IRC). On the other hand, these applications have the highest growth rate during 1996-1997, with MUDs and MOOs having a higher adoption rate than IRC. (125% and 120 % for MUDs and MOOs respectively, versus 82 % for IRC). These results approve hypothesis 2:

“The rate of adoption of the Internet text based conferencing tools including MUDs, MOOs and IRC is higher than that of the WWW and e-mail applications, during the academic years 1995-1996 and 1996-1997.”

Unlike the Web and e-mail applications, which are widely used by the respondents and are nearly at a saturation stage where growth rate is very slow, the three text based conferencing tools are still at the early stages of their adoption and are quickly increasing in expansion.

The fact that MUD has the highest growth rate can be explained by its more flexible environment than that of the IRC, and its easier programming language than the one used for MOOs. Even though, MUDs are less complex to program than MOOs, the difference in growth rates is not significant (only 5%). This primarily because of the upgraded and simpler programming languages developed for constructing MOO environments, as well as the more dynamic and flexible MOO environment which are worth the programming effort. These results agree with the research findings and confirm hypothesis 3:

“ The use of MUDs and MOOs within the telelearning environment is expanding at a faster growth rate than IRC.”

The real time video-conferencing software CUSeeMe has been used by 10% of the respondents, and will experience a 13% growth rate during the 1996-1997 academic year. On the other hand, the growth rate of CUSeeMe is lower than that of MUDs and MOOs (100% versus 125 for MUDs and 120 % for MOOs). This rate though is higher than that of IRCs. The last figure can be justified by the telelearning practitioners tendency to using the more flexible and dynamic MUDs and MOOs, than the plain text based chatting the IRC. These results accord hypothesis 4, excepting IRC in the text based tools category:

“ The growth rate of CUSeeMe for the academic year 1996-1997 is higher than that of 1995-1996, but it is much lower than the growth rate of text based conferencing tools.”

Remarkably, the other real time text based tools, which are primarily proprietary tools, will be having a comparable growth rate to that of IRC. When looking at the detailed results of the survey, those who are using these tools such as (POWWOW and FirstClass) are basically professional institutions, with trainees affording these tools. It is likely too that the users are located within proximate remote locations, mainly because of the Internet network limitations and the inadequate bandwidth over large different interconnected networks.

As anticipated, the MBONE is not used by any of our respondents, and many of them did not even hear about the technology yet. These findings approve hypothesis 4:

“The growth rate of CUSeeMe for the academic year 1996-1997 is higher than that of 1995-1996. but it is much lower than the growth rate of text based conferencing tools”.

4.6 Question 7: Audio and Video Use.

Most of the audio and video delivered over the net is on demand. Multimedia clips are downloaded by instructors and students and can be used in class discussions or as further references for student research and assignments.

Because of its lower requirements of bandwidth and low cost compared with real time video, real time audio is more popular than real time video. The fact that most audio tools are proprietary however, and due to the lack of standards, only a small portion of respondents is anticipated to be integrating the tool within their educational environment.

Real time video on the other hand, as discussed earlier under the section of question 6, is still limited to experimental applications and many users are experiencing many technical problems with them. Based on these information, the following hypothesis is established:

Hypothesis 5 :

Audio tools are: a) more deployed than video, and

b) they are expanding faster during the academic year 1996-1997.

Survey results

As depicted in the bar chart below, only 1 % of the respondents are using video while 8% are using audio. The rate of growth for audio tools is also higher than that for video tools (5% for audio versus 3% for video). These findings confirm hypothesis 5. The video lower percentages are essentially due to the scarce network resources as explained earlier.

Fig 4.7: Audio and video application for the academic years 1995-1996 and 1996-1997

Fig 4.8: Rate of growth of audio and video applications during the academic year 1996-1997

4.7 Question 8: Plans/current uses of The Internet for Course Delivery?

As depicted in the earlier in Fig 4.5 and Fig 4.6, tracing successively the current Internet tools uses and their growth rate, it is mainly the low cost but flexible tools which are predominating in a telelearning

environment. These tools mainly include e-mail and its applications, the Web and text based conferencing tools.

With regards to e-mail, the most prevalent tool, it can be presumed that it is principally applied for asynchronous student/instructor and student/student interactions. This type of interaction comprises: prolonged class discussions, virtual office hours, personal feedback, handing in assignments and quizzes, and students groupwork and projects.

Uses of the Web, which is almost as popular as e-mail, are mainly based on deploying the Web's hyperlinked environment. Many instructors for instance, use the web as a repository for class material with hyperlinks to relevant information available on the Web.

Despite the increased availability of HTML editors and filters, which can significantly reduce the time involved in translating text into hypertext format, copyright issues can limit the use of the Internet for writing hypertext manuals.

For students, the Web's vast information resources and its ubiquity provide them with a valuable tool for making searches and obtaining up to date up-to-the-minute information. Virtual institutions administrations are also using the Web to provide information about the institution and the different services it offers. Announcements and news are also posted on a web site for students and campus visitors. Taking into account the improved security systems over the Internet, and the continuous development of safer protocols and more safeguarded applications, more exams can be given on-line.

Based on these facts the following hypothesis can be formed:

Hypothesis 6:

By comparison with all the other applications of the Internet within the telelearning environment, on-line exams and real time class lectures are the fastest growing functions.

Hypothesis 7:

*Hypertext manuals: a) are not as widely used as lecture notes postings, and
b) their growth rate is lower than most of the other applications.*

Survey results:

During the academic year 1995-1996, the Internet was mostly used for asynchronous communication , on-line class discussions and students feedback . In fact, respectively 69%, 62% and 59% of the respondents

used the Internet for remote interaction, class discussions and feedback. For these functions were already highly prevailing during, their growth rates for the academic year 1996-1997, are the lowest as portrayed in the chart of the function's growth rate. Student communications has the lowest rate, (26%), followed by class discussions, (27%), and finally, students feedback, which has a rate of 31% increase.

Remote submissions of assignments and on-line lecture notes postings are also two widely applied functions of the Internet, for on-line course delivery. Respectively, 54% of respondents use the net for handing in assignments electronically, and thereabouts the same proportion (53%) have web sites with the course on-line, assignments together with half the respondents posting lecture notes, especially in cases where there is no face to face contact or any other type of real time interaction between the students and their instructor.

Although asynchronous interactions is very common between students and their instructor either on a group basis (on-line class discussions) or on an individual basis (virtual office hours and feedback), Internet tools are not as widely used for student-student interchanges, while working on cooperative assignments. Compared to 69% of the respondents use the net for student-instructor communication, in 1995-1996, 45% were using it for groupwork and 20% more will be using it during 1996-1997.

Concerning hypertext manuals, 37% of the respondents were used the Internet to reproduce and post student manuals on-line. This rate is much lower however than simpler lecture notes postings, which are restricted in most of the cases to point format notes and cross references to other material. This result conforms hypothesis 7:

"Hypertext manuals function is not as widely used as lecture notes postings.."

Remarkably, the growth of both applications is the same, 52%, and is one of the highest rates, (the third highest). This outcome disapproves the second part of hypothesis 7:

"The growth rate of hypertext manuals is lower than most of the other applications"

This can imply that despite the copyright issues, instructors are benefiting of the powerful, smooth and simple to use filters and hypertext editors, which save them significant traditional delivery and time costs.

As expected the least employment of Internet tools is for on-line exams (19%), followed by real time lectures (15%). On the other side, both functions have the highest growth rate during 1996-1997, 69% for on-line exams and 59% for real time class lectures. These outcomes compare favorably with hypothesis 6:

"By comparison with all the other applications of the Internet within the telelearning environment, on-line exams and real time class lectures are the fastest growing functions."

These results are also in accordance with the answers of question 6, where real time conferencing tools, principally MUDs and MOOs, are the quickest expanding tools. Further, the reasons provided in the previous section about the possible reasons for the increased use of on-line lectures, strongly justify the 69% growth rate.

Fig 4.9: percentage of users applying the suggested functions

Fig 4.10 : growth rate of each function during the academic year 1996-1997

Note: the option "other functions" was not portrayed in the graphs, because it required respondents to add their personal extra uses. Since these suggestions were different from one respondent to another and were applied during different periods, it was not possible to plot that data on these graphs.

Under the option “other”, where respondents were expected to provide supplementary uses of the Internet tool for a flexible on-line telelearning environment, the following functions were disclosed:

- Used for interactive computer assisted instruction modules completed by the student, that replace class lectures
- Used to download multimedia files, assignments and practice exams.
- Used it in a forum discussion format for group brainstorming, developed like a newsgroup.
- PDF documents fill informs for course evaluations.
- Case Study presentations by students using multimedia files.
- Using the on-line material as an adjunct to the traditional paper-based course guide, re-enforcing it where appropriate and providing relevant material on-line for student use during labs .

4.8 Question 9: Advantages of using the Internet for teaching/learning?

The last two questions required users to give short answers about their opinions with regards to using the Internet within a telelearning environment, either as a complementary and integral tool or as the only fundamental system for on-line knowledge transfer.

Internet based learning offers a wealth of benefits to the teaching and telelearning community. The following are some of its main valuable services:

- It improves access to a wide universal community of students:
The Internet service today is more popular today than two years ago. Also the number of commercial service providers has grown, which rose competition between them bringing down service costs, and pulling in opportunities for more people to access the technology. Moreover, because the Internet is based on standard communication protocols, and because many of its software, and plug-ins can be downloaded directly from the Internet itself, students and instructors around the world can be sure that they are able to use the same software regardless of the platforms they are using.
- It is a cost and time effective solution for delivering education and for accessing learning material.
First, costs of the required equipment for telelearning via the Internet are in most of the cases a one time investment and are continuously dropping in price. Also, most of the software and applications used can be downloaded for free directly from the Internet. Moreover, telelearning via the Internet saves the traveling time and costs to go to class, as well as the extra buildings, and faculty costs. Compared with other distance learning methods, telelearning practitioners save the costs of courier services, traditional video-conferencing equipment and setting costs and time consuming preparations for broadcasting lectures to remote sites.

- The relatively low cost electronic publishing and Internet access, combined with on-line flexible support services, such as those offered by the Global Network Academy, enable individual teachers wishing to teach without instructional support, to compete for students by giving stand alone on-line courses.
- It improves students learning: with the ability of holding asynchronous conversations with peers, instructors and experts, students have more opportunity to improve their learning and to exchange invaluable information. Extended class discussions beyond lecture time, and the ability to review previous sessions provide students with more time for reflection, analyzing and writing neat responses. It also encourages active involvement of the whole group in the discussion and helps mainly quiet and shy students. Further, it stimulates increased student-instructor interaction, which provides more support and help especially for students with special problems.
- As students are learning using advanced tools and technologies, they are using most of the tools and developing the skills that will be an essential part of their work later.
- It is highly convenient: Teaching and learning via the Internet is highly flexible. Both instructors and students are not confined by time or space, as they can access it anytime from anywhere. Further, it permits students with special needs such as physically disabled people, or those with certain life and work conditions, to benefit from educational programs and to upgrade their skills.
- It is easy to use: The different Internet software smoothly integrate the different resources providing users with a simple and user friendly interface, which is quickly and easily mastered by users.
- It improves learning resources: The Internet allows access to a readily available world wide information resource, ideal to for education and research. The ability of creating links to relevant resources such as simulation software and multimedia documents, considerably supports teachers in their preparation of the course material and provides students with high quality learning resources.
- The ability of incorporating hypermedia, simulation software and real time multimedia applications provide considerable support for a telelearning environments. It permits the delivery of sophisticated instructional material to students anywhere. At the same time, using such tools improves the technological capabilities of students and instructors and helps them to get acquainted with the different features of the continuously developing Internet technologies.
- Internet material development is relatively easy, quick and low cost: development of instructional material and uploading it to the Net is easy and can be done very quickly. the HTML language used to do so is very easy to learn and provides several capabilities and options for presenting information in different formats. Further, unlike printed resources, the Internet presents a powerful tool for publishing and updating I information at low time and money costs.

Survey results

The following is a list of the benefits and conveniences our respondents believe the Internet provides, to operate within a telelearning on-line environment.

- It provides global access a large audience;
- It is flexible;
- It permits the easy processing of a large number of students tasks and provides self paced learning;
- It allows for more open discussions with people form all over the world;
- It allows ANYONE to access and learn ANYTIME they wish to learn about nearly any subject;
- It allows for a global and fairly inexpensive education;
- It is time efficient in terms of reaching students and instructors any time and anywhere;
- It grants an easier, faster and more convenient communication between students, instructors and administration;
- It allows for a more efficient use of class time
- It helps students develop new skills, such as: discussion, writing, thinking, collaboration, computer literacy, etc.;
- It is of great value for isolated students/countries;
- It facilitates one-on-one tutoring, therefore allowing and encouraging students who might be reluctant to participate in class, but have equally valid points to be made;
- It Increases student motivation and involvement in the learning process;
- It provides a wealth of information resources for students and instructors;
- It has spurred creativity! It also allows for the most up-to-date information for research papers;
- Allows for a rapid generation of custom course materials in place of a standard textbook authored by the instructor;
- It provides up-to-date material and allows for frequent adjustments to course syllabus;
- It opens up a world of diversity and multi-culturism;

4.9 Question 10: Disadvantages of using the Internet for teaching/learning?

Despite the long list of the Internet benefits for on-line telelearning via the Internet, this medium also has some disadvantages and issues which should be taken into consideration and worked on before implementing an on-line class via the Internet. Some of the main issues such as economics, security, accreditation and copyright will be discussed later in part IV. The following are some other minor issues which can affect the efficiency of the telelearning environment to a certain extent. These include:

- Time difference between the different world areas can cause certain communication problems when using real time applications, limiting the effectiveness of these tools for some multinational groups.
- Increased developments of high bandwidth technologies require higher speed Internet access, which is not yet available at affordable prices in many areas around the world. This can deprive many students from using the Internet's powerful features and can even limit some courses efficiency especially for courses where multimedia is very necessary such as medical classes.
- The wide information resources can errant students during their search for information and can easily result into information overload.
- The added responsibilities for on-line teachers may discourage many from pursuing this method of instruction, especially in case of large classes.
- Many faculty members are worried that the Internet can represent a threat to human resources, since one professor can serve thousands of students. This would reduce the number of faculty members and could result in a loss of diversity.
- Based on many Internet and computer users experience, reading long documents over the computer monitor is not as comfortable as when reading a printed document at the reader's convenience (i.e. while lying down, standing, walking, etc.). This can be explained by the fact that on-line documents have less resolution than paper. As a result, users incur extra printing costs which increases expenses of using the Internet medium for telelearning.
- Using the computer for too long can cause several health problems. Sitting for too long can result in back problems. Prolonged on-line reading sessions can stress the eyes. Using high keyboards, ill-fitting chairs, working in stressful conditions, typing for extended hours of typing, and frequent use of the mouse, can tear the muscles, nerves and tendons, which become irritated and inflamed. This problem is known as the Repetitive Strain Injury or RSI. All these health problems represent extra hidden costs for telelearning via the Internet.

Survey results:

Respondents had several comments about the shortcomings and problem areas of the medium, which should be worked on in order to benefit of a smoother and a problem free on-line environment. The main remark is that many of the issues that respondents were experiencing, most of them have been either solved or are being worked by the Internet experts, such as security matters and technical problems like bandwidth and technical support.

The following are the main criticisms of our respondents:

- Much of the information is irrelevant, therefore students can easily have an information overload and can lead to a loss of time searching;

- The availability of scientific research on the Internet is relatively limited, compared to commercial files and descriptions of companies/educational institutions;
- Many technical problems including: connection, access to material, delays and cut off, slow downloading of multimedia files, low bandwidth;
- Time consuming dealing with technical problems;
- Lack of students and instructors to computer literacy;
- Continuous need to technical support;
- Technical problems quickly lead to student frustration therefore affecting their concentration during the class session;
- Time zone problems;
- Searching can be cumbersome and clumsy;
- Some sites are not easy to access or disappear and change address;
- Lack of security;
- Increased workload for instructors;
- Current Internet tools are not fully adequate to students needs;
- Social campus aspects can be replicated;
- Paying for access is a problem for students;
- It is hard for instructors to keep discussions in harmony;
- High risk of flaming and inappropriate behavior during discussions;
- Academic resistance to this new way of teaching;

4.10 Conclusion:

Based on the survey's outcomes , the main conclusions can be summarized as follows:

- The Internet's ubiquity and easy access, coupled with the increased developments and proliferation of its tools are opening up new opportunities for telelearning students and institutions, who have already started deploying the medium towards the initiation of a flexible learning environment. This concept is confirmed by the fact that by the academic year 1996-1997 almost all the respondents will be using the Internet as an integral tool of their course delivery. The institutions which were deploying the Internet for their educational delivery were not limited to only high level institutions such as universities and professional organizations but also involved colleges, primary and high schools.
- The main powerful aspect of the Internet which strongly encouraged our respondents to adopt the different Internet tools, is the easy reach to class members any time and anywhere, which resulted in

improved communication between them. Furthermore, cost efficiency was also among the main reasons which invited users to use the Internet, in addition to the previously mentioned ones.

Unlike what many people would think, our respondents did not consider that quick and easy research are among the most important reasons for implementing the Internet tools to support on-line course delivery.

- Given the current network limitations, and broad bandwidth connections high costs, low bandwidth modules which mainly involved e-mail applications were the most prevalent tools used for on-line distribution of learning material. Real time text based tools which provide flexible cyber environments and live interactions, principally MUDs and MOOs, on the other hand, are quickly increasing in popularity among the educational community. The real time video-conferencing software, such as CUSeeMe, is also being highly promoted, especially with the continuous upgrades in its technology. User education about the best ways of deploying these tools would grant users higher quality environments and an increased efficiency. Not until high speed connections become affordable and network issues are solved, would the majority of the telelearning community start adopting high bandwidth technologies such as the MBONE.
- Taking into account the network issues stated earlier and the scarcity of bandwidth, multimedia applications are limited to downloads of multimedia web files, to supplement presentations and research projects. The lack of standards, is a significant discouraging factor for the widespread telelearning community to adopt these tools for on-line delivery of educational material. Analogous to the case of real time multimedia applications, network improvements would considerably promote the integration of these media.

Despite the fact that many of the respondents still consider the Internet as being insecure, upgrades in the network security field, has been motivating other telelearning practitioners to use the medium for giving or taking on-line exams. Furthermore, the unsolved electronic material copyright issues did not really hinder many of our respondents from providing their students with on-line hypertext manuals.

- Despite the various advantages of using the Internet within a telelearning environment, several issues such as network security, bandwidth insufficiency and costly high speed connections are still presenting obstacles for a higher quality on-line educational environment and more efficient and smooth interactions. The Internet experts and developers, however are currently working on solving these issues and on upgrading the medium and making it more convenient for the Internet user community including telelearning practitioners.

Other issues such as the ability to monitor on-line discussions, on-line class material preparation time and effort investments, training needs and technical support required are temporary issues which are solved soon as the users get more familiar with the tool and become able to use it smoothly.

Chapter 5:

Yahoo! Internet life. SURVEY ANALYSIS

5.1 Introduction:

During the month of March 1997, Yahoo! Internet Life magazine, conducted a survey that attempted ranked the most wired higher education institutions in the United States. The survey queried 300 colleges and universities on 35 different Internet related factors, organized under four main categories: hardware, academics, student affairs and social services. Answers to questions of the top 100 most wired institutions were published on-line, as well as an explanation of the method used for rating. While academics accounted for 45% of the total score, hardware and social use of the net constituted each 22.5%. Student services comprised 10%. Items such as the college web page content, aesthetics, or navigability were not taken into consideration, as it was believed that these can be very misleading in assessing the extent of available Net services to students.

The analysis of the findings was very brief, and there were no comments explaining the facts but a listing of percentages of the different answers. The accompanying article "America's 100 Most Wired Colleges", by Dina Gan, mainly talked about future expectations of the new wired educational environment, but there was no study of the present Net deployments. For that reason, we have studied the results by summarizing the survey's result of a selected set of the surveyed institutions, in a table. Next, we analyzed these results and deduced a set conclusions about the new trend of on-line telelearning via the Internet. The set we selected includes the three top most wired ones as well as some of the major universities at lower ranks, such as Stanford and Harvard universities. Our comments will only focus on the top 100 schools since no information was published about the other 200 schools. Results are classified according to the four categories in summary tables, followed by a discussion of the findings. We note that the majority of the questions were included, except a few which were not of immediate relevance to our subject.

5.2 Hardware:

Questions under this category intended to investigate elements such as: the proportion of student owning computers vs. those which belong to school, the number of computers per student, Internet and on-line library access, e-mail accounts and server space for students' web pages.

The following table gives a snapshot of the Internet services offered by our selected set of institutions. The factors considered are:

- Student owned computers: this factor provides a percentage of the students who own the campus computers.
- Port to student ratio: this ratio is the number of ports available per student; best is 1:1.

- Default e-mail account: means that students automatically get an e-mail account.
- Web page: asks if students are offered automatically room for their own Web page.
- Unlimited Web access: surveys whether student are offered unlimited Internet access or not. Since some schools require extra fees for use beyond a certain number of hours.
- On-line library access: investigates if students are having access to the campus library or not.

Table 5.1 : Summary of responses to the Hardware and Wiring category

Rank	College name	Student owned computers (%)	Port to student ratio	Default e-mail account	Web page	Unlimited web access	On-line library access
1	MIT	80	1:1	YES	YES	YES	YES
2	North Western	90	1:1	YES	YES	YES	YES
3	Emerson	90	1:1	YES	YES	YES	YES
5	Dartmouth	100	1:1	YES	YES	YES	YES
6	U. of Oregon	50	1:1	YES	YES	YES	YES
7	NJIT	100	1:1	YES	YES	YES	YES
17	U of Berkeley	75	3:4	YES	NO	YES	YES
50	Cornell U.	80	1:1	YES	YES	YES	YES
55	U of Michigan	60	2:3	YES	YES	YES	YES
57	NYU	60	1:3	YES	YES	YES	YES
60	YALE	80	1:1	YES	YES	YES	YES
64	HARVARD	97	1:1	YES	YES	YES	YES
78	UCLA	55	1:1	YES	NO	YES	YES
84	Stanford	40	1:1	YES	YES	YES	YES
100	Millsaps	10	1:1	YES	YES	YES	YES

In many of the surveyed institutions, students can own the campus computers, while others belong to the school. As we can notice above, percentages vary widely as we go down the ranking, ranging between 100% down to only 10%. Despite that, we notice that the port to student ratio was very good(1:1)in most of the listed schools in our table and in 75% of the whole group. These results reflect that the majority of these schools have the adequate level of computer resources to support an on-line networked environment. Schools with low ratios, explained that funding problems are the main constraints of achieving the 1:1 ratio.

When it comes to on-line access to library catalogs, unlimited Web access, default e-mail and student Web pages, we notice that these applications have become a guaranteed service for students, and that institutions are encouraging wide Internet access. Figures recorded that all the institutions offer on-line library access, 99% offer unlimited web access, 98% offer default e-mail accounts and 87% offer students Web space for home pages.

5.3 Academics:

This is the most important and weighty category which judged how well an institution is using the Internet for on-line teaching and learning. The factors considered are the on-line use of classes of the Internet for Web pages, on-line homework and on-line study aids.

Table 5.2 Summary of responses to the Academics category

Rank	College name	Classes with web pages (%)	Classes with on-line homework (%)	Classes with on-line study aids (%)
1	MIT	40	90	60
2	North Western	60	40	60
3	Emerson	50	55	60
5	Dartmouth College	100	100	100
6	U. of Oregon	80	40	40
7	NJIT	33	12.5	25
17	U of Berkeley	40	N/A	40
50	Cornell U.	N/A	N/A	N/A
55	U. of Michigan	25	N/A	N/A
57	NYU	5	2	2
60	YALE	10	7.5	N/A
64	HARVARD	N/A	N/A	N/A
78	UCLA	6	N/A	N/A
84	Stanford	5	2	5
100	Millsaps College	5	5	20

The first observation is that, as we go down in the ranking, the use of the Net for on-line class activities decreases and is not available in several cases. For instance, while all the courses at Dartmouth University and 80% of classes at the University of Oregon have Web pages, only 5% and 6% of the classes, respectively at Stanford University and at UCLA offer on-line services. No class at Harvard University, has an on-line element. These results can be explained by several facts. First, as admitted by many administrators at institutions with low ratios, much of their faculties "are still averse to this stuff (i.e. the Internet)". Several institutions can view the Internet as a threat to their autonomy and a means of diluting and homogenizing standards. For individual universities, such as Stanford and Harvard Universities, putting their course on-line for the open public would mean the loss of their distinctive flavor and an over-standardization of courses.

Smaller and less popular universities can use the Internet, as a powerful marketing medium which helps accessing the large universal "market of students", and therefore increasing their enrollment rate. Bigger institutions on the other hand, which want to preserve their face-to-face tradition, would simply use their reputation as a factor to attract more students.

Besides, colleges and universities which are already offering distance education and lifelong learning programs and courses, such Dartmouth College, have very high academic scores. These institutions are using the medium to offer their remote students with a flexible learning setting, where they can access their class lectures any time and anywhere and they can fulfill their class requirements on-line. Other institutions with low academic scores, are willing to go on-line and are already in the process of doing so.

5.4 Student services:

Questions under this category, looked into the use if the Internet for student affairs. These included on-line registration, on-line add and drop of courses, on-line transcripts and on-line syllabi. The following table summarizes the responses of the selected group of institutions

Table 5.3 Summary of responses to the Student services category questions

Rank	College name	On-line registration	On-line add/drop	On-line transcript	On-line syllabi
1	MIT	YES	YES	NO	YES
2	North Western	NO	NO	YES	YES
3	Emerson	YES	YES	YES	YES
5	Dartmouth	YES	YES	NO	YES
6	U. of Oregon	YES	YES	YES	YES
7	NJIT	YES	YES	YES	YES
17	U. of Berkeley	YES	YES	YES	YES
50	Cornell U.	YES	YES	YES	YES
55	U. of Michigan	YES	YES	YES	YES
57	NYU	NO	NO	YES	YES
60	YALE	NO	NO	NO	YES
64	HARVARD	NO	NO	YES	YES
78	UCLA	NO	NO	YES	YES
84	Stanford	YES	YES	YES	YES
100	Millsaps	NO	NO	YES	YES

Of the 100 most wired American colleges and universities, only 29% allow for on-line registration and 28% allow on-line add and drop of courses. On the other hand, 43% of these institutions allow students to view their transcripts on-line and 100% have on-line syllabi and summary of their offered programs. Many respondents, justified security and privacy are two main factors which limited the use of the Internet for certain student services such as accessing grades and transcripts. Usually, this type of information is considered very sensitive and personal for students but the Internet environment is still not well secure to guarantee private transmission of this information to students. Syllabi, on the other hand, which provide web site visitors with general information about the institution are available at all institutions since they do not present any security concerns for administrations. Such results along with the Internet security and

privacy reasons can justify the reason why the weight of this category is the lowest, since providing private information on-line is not an adequate factor to judge an institution's on-line services. A case in point is Dartmouth college which offers scores very high in academics but it still does not allow on line transmission of transcripts.

5.5 Social services:

The last series of questions examined the different on-line social services offered for students. Some of these factors we considered in our summary are the possibility of having student web pages on the school's Web system, club Web pages, on-line chatting, events listings and newsgroups. The following table summarizes the results of our selected set of institutions.

Table 5.4 Summary of results for the Social Services category questions

Rank	College name	Student web pages	Club web pages (%)	On-line gaming /chat	Events listing	Newsgroup hierarchy
1	MIT	YES	100%	YES	YES	YES
2	North Western	YES	70	YES	YES	YES
3	Emerson	YES	80	YES	YES	YES
5	Dartmouth	YES	70	YES	YES	YES
6	U. of Oregon	YES	80	YES	NO	YES
7	NJIT	YES	100	YES	YES	YES
17	UC Berkeley	NO	90	NO	YES	NO
50	Cornell U.	NO	90	NO	YES	NO
55	U of Michigan	YES	80	NO	YES	YES
57	NYU	YES	60	NO	NO	YES
60	YALE	NO	33	YES	YES	YES
64	HARVARD	YES	80	NO	YES	YES
78	UCLA	NO	50	YES	YES	YES
84	Stanford U.	YES	25	YES	NO	YES
100	Millsaps	YES	20	NO	YES	YES

As portrayed above in table 5.4, and based on results for the whole group of the 100 most wired institutions, most social services are available in almost all the institutions, except for the on-line gaming and chat. Results report that 85% of the most wired institutions host a campus-based newsgroup hierarchy and 87% offer students Web space for a home page. When comparing results in other categories, we notice that institutions with high academic scores have also the highest scores and the maximum number of on-line social services. This can be explained by the fact that as many students will be spending most of their time hooked to the Net, browsing the institutions site, posting other institution related information such as events advertisements, clubs announcements allows student to be informed about the institution's activities like any other students on campus. Moreover, newsgroup hierarchies and chatting settings complete the scene of a virtual campus environment.

Many of the surveyed institutions however, discourage extracurricular services, especially on-line gaming and chatting, as they are a “drag on resources”, as one administrator puts it. Another staff member justified that the reason why his institution is not keen on on-line chatting is that they “don’t want to facilitate chat groups that pertain to all manner of things that have nothing to do with their education”.

5.6 Conclusion

Based on this survey’s results, we came to the conclusion that a growing number of American institutions are integrating the Internet within their learning environment. At this time, unlimited access to the Internet, the WWW and on-line libraries, as well as a default e-mail account and campus based newsgroups are becoming guaranteed services for American students. However, several institutions are still very wary when it comes to administrative services, such as on-line registration, on-line transcripts and course selection.

Despite the increased prevalence of the Internet among American institutions, certain institutions especially distinctive ones, such as Harvard and Stanford universities, are till now not very keen on using this medium for on-line education. This fact hints that face to face settings will be still around and that there will be always people who would favor the traditional setting over the emerging virtual telelearning environment for different reasons, such as concerns about standardization and loss of autonomy.

CONCLUSION:

The academic environment is undergoing different trends which are reshaping it and are resulting in the emergence of new forms of instruction and learning and new academic structures. These trends can be classified into teaching and learning trends and organizational trends.

Teaching and learning trends:

The first main teaching and learning trend, as portrayed in the two surveys and case studies, is the fact that many of the Internet tools are becoming an integral part of the education process, primarily e-mail and its different applications and the Web. At the same time a quick evolution is taking place from low bandwidth asynchronous applications such as e-mail and Text based real time conferencing tools such as IRC, and MUDs and MOOs, towards higher bandwidth multimedia on demand and real time applications such as multimedia e-mail, multimedia 3D MUDs and MOOs, and the video-conferencing tool CUSeeMe. Despite this progress, issues like security, copyright and the open access to inappropriate and/or low quality Internet material, still represent a limit the use of the Internet for sensitive operations such as accessing educational material, on-line fee payments, on-line registration, and on-line transcripts.

The second meaningful trend is the increased use of multicast capabilities, primarily using the video-conferencing tool CUSeeMe. The new MBONE technology on the other hand, is still not familiar to the surveyed institutions. This can be explained primarily by the experimental stage of the technology and the lack of support to the new multicasting protocol by the ISPs.

Organizational trends:

When it comes to the organizational trends, the surveys revealed that many educational institutions are increasingly offering on-line services, programs and degrees to the worldwide learning community. This new direction in their strategy will play a significant role in increasing the enrollment rate of students and might even help them solve some of their financial problems.

At the same time, a new form of academic institution has emerged which are totally on-line and use only the Internet medium for all faculty operations and teaching activities, including lectures, testing, discussions, etc. Furthermore, the rise of on-line flexible support services, such as those offered by the Global Network Academy, combined with the relatively low cost electronic publishing and Internet access, has encouraged

many individual teachers wishing to teach without instructional support, to offer stand alone on-line courses.

Finally, one important remark about the deployment of the Internet medium, is that almost all the respondents and the available case studies were from the USA followed by Canada, and then Europe. This assertion is confirmed by the last survey of the Graphic, Visualization, & Usability Center's (GVU) 6th WWW User Survey, which reported that 83% of Web users are from the US, 6% come from Europe, and just under 6% from Canada and Mexico. This fact can be explained by the wide and easy access to the medium in these areas of the world compared with other countries.

Part III:

ECONOMICS OF TELELEARNING VIA THE INTERNET

Chapter 6: STUDENT RELATED COSTS

Chapter 7: INSTITUTION RELATED COSTS

INTRODUCTION:

Costing the use of the Internet technology for telelearning is a difficult and complex assignment because of different reasons. First, the international aspect of the Internet technology, and the worldwide access to on-line resources adds significant complications to the costing procedure, as it is very difficult to develop universal costing measures. Second, with the quick technological developments of the Internet tools and applications, it is still difficult to outline a simple and standard cost structure, which can be applied to all institutions using the Internet medium for telelearning.

Furthermore, with the increased adoption rate of these developments by educational institutions, as well as individuals, limitless options and scenarios of applying these tools are being applied, which adds complexity to the costing process. For instance, costing a course using a combination of text, multimedia and live audio/video which is being multicast to participants who are also using different combinations of tools and access methods, can be intricate and very confusing. The fact also that telelearners are, very likely, scattered all over the world, adds extra complications since prices and charges of cost elements such as equipment, access charges, wages and many other related costs, vary widely from one country to another.

Likewise, the increased competition between the different telecommunication companies has lead to a broad variety of charges and access options. Furthermore, there is very little information about how current costs and charges such as tuition fees, instructors and tutors fees, etc. are set by virtual institutions.

In view of all these facts, attempting today to cost telelearning via the Internet can easily result into unreliable conclusions, which do not reflect correctly the actual incurred expenses.

Despite these difficulties, we tried to identify some common cost elements, which are very likely to exist in the cost structure of an Internet-based telelearning system. These elements are categorized under institution related costs and student related costs.

The student related costs include:

- Internet access costs;
- Tuition fees and;
- Other costs such as print material and courier costs.

The institution related costs comprise mainly:

- Planning and preparing the institution's strategy and general policies;

- Equipment costs, which includes hardware and software;
- Site construction costs;
- Technical support costs;
- Instructors and tutors costs, which involve: training, compensation and possible extra remuneration costs for upgrading and developing the on-line programs;
- Maintenance and upgrades costs of computer servers, as new technologies are developed;

Generally, the total costs incurred when setting up a telelearning environment via the Internet, depend on the strategy implemented by the educational institution, and on the Internet access technology chosen by on-line students. For instance, costs of an institution offering a few courses on-line would be different from an entirely on-line institution. Also, expenses of delivering educational material to a hybrid group of on-line and on campus students are higher than the case where all the students are interacting remotely. Further, a student accessing the Internet using a 28.8 Kbps modem will have less expensive, but a slower connection and a lower speed data transmission than another, who is using an ISDN line connection. This last point is very important especially in case a cost benefit analysis is needed.

In our discussion, institution related costs such as computer labs, maintenance, accommodations, computer labs staff salaries, etc. will not be included. Instead, only costs directly related to instituting a telelearning environment via the Internet will be considered.

Configuration of an on-line academic institution:

Figure 6.1 illustrates a sample connection of a virtual educational on-line institution :

Fig 6.1: Sample configuration of a virtual institution

As shown in Figure 6.1, remote students, who can be scattered in different areas around the world, connect to the Web server and access the institution's resources through the Internet network. The Web server is linked to the institution's LAN, which is connected to the Internet, through its ISP.

The following chapters will provide a more detailed explanation about the different cost elements related to students(Chapter 6) and institutions(Chapter 7).

Note: All costs are in terms of US dollars, unless otherwise indicated.

Chapter 6:

STUDENT RELATED COSTS

6.1 Introduction:

Costs incurred by students include the following three elements:

a. Internet access: discussed in section 6.2. This section includes a description of the different options available today, for accessing the Internet. Although most of these technologies, such as ADSL and cable modem, are still at an early stage, the promising opportunities they offer for high speed connections to students with limited budgets, implies that it is very likely that on-line students will be using them. Fast technological developments, competition among telecommunication companies, and the urgent need for affordable high speed connections, imply that these technologies will very soon be available for telelearners.

Remark: When costs are calculated for each technology, the cost of the computer terminal and the TCP/IP software will not be considered, since they are a common basic requirement for all access options. Both costs are one time expenses. They are estimated to have the following values.

Table 6.1 : Common cost elements of an Internet connection

COST ELEMENT	TOTAL COSTS US\$	NOTES
Computer (Mac or PC)	1500	- minimum processor of 68030 for a Mac, or 486 for a PC, and at least four megabytes (Mbs) of memory.
TCP/IP software	50	- needed to communicate on the Internet. - Sometimes provided by the Internet service provider.
Total initial Internet connection costs	1550	-costs can be lower with the computer dropping prices.

b. Tuition fees : which vary widely today between one on-line institution to another.

c. Other costs: such as learning material delivery, and encryption keys expenses, as well as other costs which are not charged to students by all on-line institutions.

6.2 Internet access:

Having an Internet access is, obviously a fundamental requirement for students willing to take a course or a degree via the Internet. The technology used to connect, depends on several circumstances, such as program and students needs, availability of the technology and the on-line students' budgets. For instance, some on-line lectures might just require an e-mail account and the ability to carry on a text based real time interaction, in which case a connection using a 28.8 Kbps modem can be adequate. In other cases, upgrades in connection might be required as multimedia tools and broad bandwidth applications are becoming more common and essential in a telelearning environment.

The first option for students to have an Internet access, is to have it through the academic institution (this is in case the institution offers both conventional and on-line classes). Many academic institutions offering telelearning courses, provide their on-line students with an e-mail account, which can be only accessed through the institution's network. The institution makes an arrangement with a local ISP to provide student with dial-up accounts. On-line students registered at the institution, get extra hours and depending on the ISP package, they can be offered free access from anywhere within the province or the country. The ISP provides all the modem access and troubleshooting. Hence, the institution wouldn't have a large strain on its server. By having this type of access, the student only bears the expenses of the necessary equipment and tools for making the connections; these include: a personal computer, a modem with a communication software and a phone line.

Depending on the student's needs, powerful computers today can be acquired at affordable prices. For instance, in its March 97 issue, PC World ranked 5 of 20 "budget desktops" as best buys and they all range between \$1700 and about \$2400. In general computer and modem prices are continuously dropping, which makes them more affordable for students with limited budgets.

The second option to have an Internet access, is when telelearners make the necessary arrangements on their own with an ISP, in which case they bear the extra costs of accessing the Internet. This option provides the student with a more flexible use of the Internet. Moreover, the expanding popularity of the Internet is pulling ISP charges down, while providing Internet users with more attractive access packages. Generally, virtual institutions expect that students make their own arrangements for their Internet connection.

The following sections describe the different Internet access technologies, which are either already available for use or are at an early stage of deployment. Choosing the most convenient technology depends on several considerations such as: access and installation charges and the availability of the technology to the telelearner.

6.2.1 Dial in modems:

The most popular and most affordable way for student to get an Internet access is using analog phone lines and a modem. Dial-up connections are the easiest and most affordable way to connect a computer to the Internet. Given the increased use of multimedia Internet files and broad bandwidth applications, such as real time audio and video-conferencing, and new technologies such as Java, VRML, Shockwave, the need for higher speed connections is becoming a very basic requirement.

Figure 6.2 illustrates the different elements of a dial-up connection.

Fig 6.2: Elements of a dial up connection

The first option for the student in order to get a faster Internet access is to upgrade his/her modem to a higher speed. The 28.8 Kbps modems have been widely used during the last year, and are selling at affordable prices ranging between less than \$100 and \$200. The more recent higher speed modems, which are rapidly expanding in use, at this time, are the 33.6 Kbps modems.

The 28.8 Kbps and 33.6 Kbps modems faster transmission rates, coupled with the built in data compression of about 2:1 for ordinary text data and by up to 4:1 for some types of data, bring in more convenience for students with limited budgets. For instance, on-line time can dramatically decrease as transmission rate increases. The 33.6 Kbps modem higher throughput helps students navigate the Web quicker, receive multimedia file attachments faster and get their homework done within a smaller time frame. As a result, telelearners can benefit better from the Web resources while saving on telephone and access charges.

A wide variety of 33.6 Kbps modems is available, today, selling for under 200\$. Most of them maintain compatibility with older, but still popular modulation protocols, and are easy to set up and use. They also offer attractive combinations of features such as voice mail, and full duplex speaker-phones, which are very useful for on-line audio and video-conferences. The cost of upgrading to 33.6 Kbps for those who currently own lower speed modems is minimal. Many modem makers are offering upgrades for a nominal fee or as free downloads from their electronic bulletin boards or Web sites. Also, many are offering PC card modems capable of 33.6 Kbps throughput.

One point to note, though, is that these modems still have some performance problems. Based on two product tests results, one published in PC Magazine (December 3rd, 1996 issue) and the second published in PC World (November 1996 issue), performance differences between the tested modems were significant. Some were even slower than some 28.8 Kbps modems. The test included a throughput vs. file type to measure the modem's ability to transfer a wide variety of file types.

Besides, the test involved a Telephone-Network Simulation, which measures how well a modem functions over a variety of line conditions typical in the public switched telephone network. The performance discrepancies were explained by two factors: first, 33.6 Kbps modems are relatively new, and therefore technical problems are still prone to exist and need to be worked out. In addition to this, an analog telephone line has an upper limit to the amount of information it can hold. Despite their 33.6 Kbps speed, these modems are limited by the quality of the analog connection and routinely go no faster than 26.4 or 28.8 Kbps. This implies that, in order to acquire higher speed access, technologies other than modems should be used.

The latest high speed modems, which were developed during the last quarter of 1996, operate at a rate of 56 Kbps, enabling users to have faster Internet connections over standard telephone lines without requiring any added investment in equipment. It is anticipated, however, that the technology will only prove itself by the end of 1997, when service providers upgrade their equipment to support the 56 Kbps access.

In order to benefit from the new high speed access, users either need to acquire new modems or they can upgrade their existing ones. Central sites and ISPs need also to make software and hardware changes to their remote access servers, and must have a digital connection to the carrier (such as a T1 or an ISDN connection)

One very interesting point to note is that theoretically, it is possible to approach 64 Kbps using this technology. Nevertheless, a number of practical problems with achieving this speed can impede such improvements. These involve: noise, non-linear distortion, line quality at the user's end (older telephone lines may not support the full 56 Kbps). Currently, the industry is working to push the technology to its highest possible data rate to make speeds near 64 Kbps possible in the future.

The new technology, however, still has several drawbacks and several problem areas to be untangled. Unlike all previous modem standards, 56 Kbps modems lack full-duplex capability. The 56 Kbps rate can only be achieved downstream to the remote user, while upstream limit is 33.6 Kbps, on account of the difficulty of equalizing the analog-to-digital stream. For telelearners, downloading or receiving multimedia from their peers is not a big concern. The issue is for two way communication, such as during on-line lectures and discussions, using video and data conferencing, or for FTP files uploads. For these situations 56 Kbps modems will offer no benefit over the less expensive 22.8 and 33.6 Kbps modems.

Furthermore, even if users have the right modems, they may not be able to have 56 Kbps access. Achieving 56 Kbps rate depends on the local loop line quality at the user's end. Older telephone lines may not support the full 56 Kbps.

Besides, unlike the traditional modems which operate in an isolated environment, 56 Kbps technology is one component of the network. Upgrades of the first modems from 14.4 Kbps to 28.8 Kbps and later to 33.6 Kbps were quick and easy. Implementing the 56 Kbps modem technology, on the other hand, will take time for two main reasons. First, developers need to educate users about this new technology, and second central-site equipment providers have to incorporate the technology into their plans.

Finally, the fact that no 56 Kbps standard has been yet worked out, can discourage the use of these new tools. It is anticipated that this issue will only be solved by the end of 1997. Meanwhile, several proposals to implement the technology are emerging, which are likely to cause incompatibility between users, ISPs and central site modems. To avoid such problems, users who are planning to purchase 56 Kbps modems should buy the same brand being used by their ISP to ensure the full 56 Kbps downstream capability. Otherwise, the transmission drops back to 28.8 Kbps (or 33.6 Kbps) data rates.

Several companies are currently working on these issues and new solutions are emerging. One of the latest technologies, for instance, permits for symmetrical mode, which transmits data at 45 Kbps in both: the downstream and upstream directions. This improvement will allow for more applications requiring fast rate transmissions, such as real time live lectures and multimedia file exchanges.

Costs for students:

When a modem is used for Internet access, the only involved cost is that of purchasing the modem. No installation by a technician or maintenance fees are required. Price, does not always reflect the quality and the performance of a modem, however. An on-line student needs a good high-speed modem which is able to get the most out of the current modulation specification, handle noisy telephone lines, work with a wide variety of file types with fidelity, and utilize the latest features that the phone networks offer.

The increasing availability of the 56 Kbps modems, and their affordable prices, and multiple conveniences promise on-line telelearning students and instructors wide opportunities for operating more effective real time lectures.

First, the anticipated costs of these modems are \$200 when they were first introduced, and are dropping to under \$100 later. This means that an on-line student can acquire a more powerful modem than the

commonly used ones at nearly the same price. Moreover, unlike other high speed technologies such as ISDN (in case an ISDN and a regular telephone are required), 56 Kbps modems require no special complex configuration or special services from the telephone company. Consequently, users will not incur any line installation fees, and do not have to go through the configuration and installation processes. Their responsibility is limited to the minimal equipment upgrades.

Furthermore, in order to save users the costs of new investments as standards develop and technology changes, 56 Kbps modem developers have designed the new modem technology so that:

- They are backwards compatible with existing 28.8 Kbps and 33.6 Kbps modem technology, and
- That it is software upgradable. This means that modems can be upgraded by downloading software via the Internet rather than by buying new equipment.

Despite the lack of standards, already hundreds of modem manufacturers and ISPs support Rockwell's K56flex technology, which has driven widespread acceptance of the protocol.

With all these upgrades and developments in the high modem speed rates, which are on the way of overcoming many of the new technologies drawbacks, the 56 Kbps data rate seems likely to establish itself as the next modem standard. Right now, several major ISPs have already started their services upgrades to support it, providing Internet users, primarily the on-line educational community, with high speed accesses and better real time services. The imminent advent of the 56 Kbps technology and its several advantages, along with the emergence of other affordable high speed technologies, such as ISDN, ADSL and cable modems, provides users with a range of options to suit their needs. Internet users, primarily, telelearning practitioners, should consider several factors before implementing a technology. Some of these criteria involve: associated costs, convenience, and the tool's performance.

The following sections describe three of the fast emerging high bandwidth technologies, which can represent potential possibilities either now or in the near future for the on-line educational community. These are ISDN, ADSL and Cable modems.

6.2.2 ISDN: Integrated Services Digital Network

Compared to other high speed technologies which are likely to be considered when choosing an affordable Internet access, ISDN is the most mature and widely available technology. Internet users craving for high speed connections and bandwidth have quickly pushed this technology to become popular.

ISDN stands for Integrated Services Digital Networks. It is a digital telephone service, which works over the existing analog telephone lines. ISDN can carry voice, data, faxes and video simultaneously, without needing a modem to translate the generated bits at both computer ends into analog signals.

There are several types of ISDN services. The most appropriate type for individual computer users is the ISDN Basic Rate Interface (BRI). BRI divides the telephone line into 3 digital channels: two 64 Kbps B (or Bearer) channels, and one 16 Kbps D (or Data) signaling channel. The B channels can carry data or voice or both. Telephone companies, in general, provide ISDN users with the options available for regular telephone calls, such as call display, call forwarding, long distance discounts etc. B channels can transmit at a rate of 64 Kbps or 56 Kbps depending on the telephone company's switch or central office. They can also be bonded to act as a single 128 Kbps, providing a connection up to four times faster than the standard modem connection. (Bonding is an acronym for Bandwidth On Demand Interoperability Group). The D channel handles the administrative work such as setting up and tearing down the call and communicating with the telephone network.

Figure 6.3, illustrates the different ISDN channels and the elements of an ISDN connection to the Internet.

Fig 6.3: Elements of an ISDN connection and the different ISDN channels

ISDN advantages:

ISDN popularity is attributed to several advantages:

- **High quality connections:** ISDN uses digital signals, which prevent the static and noise often affecting analog conversations and offer high quality static-free conversations worldwide. This feature is very useful for telelearners to make quick connections without having to wait for data modems call negotiations.
- **High speed transmissions and more broad bandwidth applications:** The commonly available modems have a maximum speed of 33.6 Kbps, but are limited to the quality of the analog connections and in many cases transmission cannot exceed 26.4 or 28.8 Kbps. The new 56 Kbps modems, as

described earlier use special technology to provide high speed transmissions, but they are still not standardized. ISDN, however, is widely available today, and it allows multiple digital channels to operate simultaneously through the standard phone wiring reaching a speed of as much as 128 Kbps, when bonding is applied. This extra bandwidth is valuable for heavy Internet users, such as telelearners, especially when downloading and uploading multimedia files, browsing graphics and animated Web pages, and holding video-conferences.

- **Multiple services:** Before the introduction of ISDN, it was necessary to have a phone line for each device a user wants to use simultaneously, such as telephone ,fax and computer. Technically, ISDN refers to the delivery of a specific set of digital services through a single interface. By applying ISDN, several data sources can be combined and routed to their proper destinations. Because the line is digital, noise and interference is kept out while combining the signals.
- **Signaling:** Instead of the ring voltage sent to ring the bell of the user's bell, ISDN sends a digital packet on the D channel. This signal does not disturb established connections, and call set up time is very fast. To illustrate, ISDN uses less than 2 seconds to establish a connection, while a modem takes 30-60 seconds. The received signal indicates the caller, the dialed number and the type of the call (data/voice). This method of signaling is very useful for telelearners especially when performing multiple activities at the same time. For instance, with ISDN, an on-line student can download Web pages, send files to other students, and receive calls without disturbing any of these activities.
- **Acceptable rates:** Compared with dial-in modems limited convenience, ISDN monthly charges of about \$50 to \$80, are acceptable, especially when the telephone company acts as the ISP where ISDN and Internet access charges are combined into one fee. Likewise, ISDN hardware are constantly falling in prices and extra installation costs are applied occasionally, in case the user requires an extra telephone line

Issues with ISDN:

Despite all the above mentioned advantages and promises of the ISDN, it still has some problem areas which need to be worked on.

Unlike analog telephone services, ISDN is not yet ubiquitous. While most urban and suburban areas can have access to ISDN services, most rural areas are not served yet. Even for urban areas, users may not get the service. In order to have an ISDN connection, the local phone company has to install an ISDN switch in its central office that serves the users. The ISDN switch consists of: a regular digital switch, the ISDN software and ISDN interfaces to the customers. Even if all the required equipment is installed at its central

office, the phone company may take too long to support the high speed transmission, since ISDN works only within a radius of 18000 feet radius from the central office, or the telephone company's remote equipment. Figure 6.4 illustrates the two possible scenarios for an ISDN connection: case 1: through the telephone company remote switching equipment, and case 2: directly from the central office.

Fig 6.4 : Possible ISDN connections between the user's premises and the telephone company's central office

One other issue is that there should not be any aberration near the wiring, which might interfere with the transmission. To prevent these problems, usually the phone company performs a "line qualification" to determine whether the user's wiring will support ISDN or not.

In order to overcome the distance and interference problems, some telephone companies are offering today, a service called "ISDN Anywhere". Under this service, even if the telephone company doesn't have the right equipment in the users' local central office, it tries to serve them from another exchange using the "line extension" technology. This option allows more users to get the ISDN services, but at a significantly high cost. This implies that many telelearners can be deprived from the ISDN benefits, since it is very unlikely that they would incur excessive costs to get the service. Fortunately, many areas around the world are expanding their support to this technology, which promises an easier access to a larger number of users.

Another problem is that sometimes even if the phone company offers the ISDN services, not all ISPs offer ISDN access. Even those who provide ISDN, usually support a limited variety of ISDN equipment. This problem, however, is on its way of being solved, as ISDN service is becoming more common and demand for high speed access is increasing. Most ISPs, today, are more motivated to open up their networks for ISDN services, especially with the increased competition from telephone companies who are starting to

operate as ISPs. A case in point, is AT&T and Pacific Bell, which are offering their own Internet services to residential and business customers, while others have started to work closer with system integrators. The increased competition, is very likely to improve services for end users, and to bring access costs down. This would of great benefit for the Internet -based telelearning community with limited budgets.

One occasional problem, is that the process of installing an ISDN line is complex and time consuming. Unlike normal analog phone lines, an ISDN line provides many options and choices which must be defined in advance in order for the line to function. It is this increased flexibility which adds complexity to the ISDN line configuration. As the telephone companies are standardizing to few preset configurations, and many ISDN equipment manufacturers are starting to support more provisioning configurations, this problem will be soon eliminated.

Finally, one point to watch for when using ISDN, is that an ISDN line connection through the ISP won't speed Internet access much, if the provider is over saturated; that is if the line is always busy or the user just can't get a response. This issue can be substantial in case of real time class discussions, where students are scattered in different areas around the globe. Network high saturation rates can considerably lower the efficacy of the connection, especially when the problem occurs at different time intervals for several students, which negatively significantly lowers the efficiency and the fluency of the lecture.

Many emerging changes, nonetheless, promise varied solutions to such problems. First, ISDN technologies and connections are constantly upgraded, and many ISDN products are becoming more sophisticated. Likewise, the expanding international usage promises a big potential of the ISDN. Today most of Europe and Japan is digitized., while other countries are digitizing their telephone networks. Finally, as more and more ISP' s are opening up their networks and are including ISDN services, saturation is very likely to be reduced, and new technologies for guaranteeing continuous access, such as switching connections to less saturated nodes could be applied.

Requirements for an ISDN service:

In order to have access to ISDN services, the following steps are requisite :

1. First, the user should check with the local phone company if ISDN service is available in the user's area. In many cases, the user would need to live near the phone company switching office for the line to have sufficient clarity for digital transmissions. In Ontario and Quebec, Bell Canada's ISDN service "Bell Z@P" is available today in a wide range of areas.
2. Then, they should, verify if the ISP supports ISDN and if it offers an ISDN Internet dial up.

3. In case a Plain Old Telephone Service (POTS) telephone is needed in addition to the ISDN telephone, the telephone company should install an additional line to the user's premises.

To fully appreciate ISDN speed, a powerful personal computer with high speed serial port and convenient hardware and software are required. The user would need a minimum 386 CPU (or faster), 8 MB or more of RAM, a sound card and at least 256-color resolution. At this time, Windows 95 is the best operating system to work with, in virtue of its various features supporting ISDN, and its special ISDN accelerator pack bonus.

For the speed of data running into the user's computer, a fast serial COM port is required, such as 16550 UART. Most IBM compatible 486s and virtually all Pentiums come with such a port, today.

4. A terminal adapter or ISDN modem should be also installed. ISDN modems neither modulate nor demodulate signals. Instead they terminate the phone company's ISDN line, packing the digital signal down the PC's serial port. These devices, which come in external or internal models, include several interesting features. For instance, many models include an analog port which allows the connection to fax machines and telephony devices. Hence, the user can utilize the ISDN line for both data and phone traffic, without purchasing an expensive digital telephone. Other features comprise: voice and data calls, remote access to LANs, telecommuting, BBS access, groupware, and large file transfers. ISDN equipment prices are dropping rapidly. Terminal adapters can now be purchased for under \$300.

The difference between an ISDN modem and an ISDN adapter is a trade-off between convenience and performance. As ISDN modems connect to the PC serial port, they are limited to the port's speed, which can be slow especially for old style UART ports. Adapters on the other hand do not face this limitation, since they connect to the computer bus. ISDN adapters, however, are more difficult to set up, because they require a technical network expertise, which represents extra costs for the end user. As more telephone companies are subsidizing ISDN equipment, it would be better for on-line student to get an ISDN adapter, given its higher performance.

5. Finally, in addition to the ISDN service and hardware, a proper software is required to enable the adapter to be integrated with other parts of the operating system. The most common way to provide connectivity over ISDN lines, is using the Point to Point Protocol (PPP), which is the protocol typically used to access the Internet. Windows 95, Windows NT or later versions, offer native support for PPP and ISDN. This results in an easy software configuration, higher performance, and an excellent interoperability with a broad range of ISDN equipment. Some ISDN service providers offer technical support for hardware and software installation for a fee.

Figure 6.5 illustrates the internal wiring in a user's house and the required ISDN equipment.

Fig 6.5: Internal wiring for an ISDN connection with an ISDN and a POTS telephones

Source: <http://www.bell.ca/bell/eng/promo/zap/wiringdoc.htm>

Costs for students:

An ISDN service charges consists of 4 components:

1. Access charges:

The access charges usually depend on the user's location and how the user was provided the service (i.e. whether the telephone company used a line extension or not). Access charges include two portions:

- *a monthly fixed charge*: recurring each month for having access to the ISDN line. In Canada, an ISDN line is offered at a monthly rate of \$51 to \$57, depending on the telephone company. (Bell also charges \$51 to \$57 depending on the user's location)
- *a usage charge* which varies depending on the amount of time spent using the line. Typically, it is not more than a couple of cents per minute (for instance Bell charges \$1.00/hr/channel), with maximum rates to about \$110. (Bell's applies a cap of \$50/channel/month). The monthly charge may include a certain number of hours of free usage each month. Some packages have no usage charges at all, or may waive usage charges during evenings and weekends. Services such as long distance discounts can be also applied. For instance Bell's Bell Z@P ISDN Service only applies usage charges to local calls made between 7:00 am and 7:00 PM (Monday to Friday). Calls made between 7:00 p.m. and 7:00 am and weekends are free.

2. Terminal requirements costs :

These are one time start up costs, and they include:

- *Terminal costs*: Which is the cost of the terminal adapter or ISDN mode. These are usually bought from the ISP or the telephone company. They range between \$300 to about \$1000, depending on the performance, the quality and the features.

- **Software installation and configuration costs:** As mentioned above, with Windows 95, the software installation and configuration can be done easily. However, the user might still need support and advice about the new service. Many telephone companies offer the help of a qualified service technician to do all the hardware and software installation and configuration.

3. Internet Service Provider:

Since many ISPs are offering the ISDN service as part of their package, they usually charge the same rates as to standard modem rates. The increased competition among ISPs and with telephone companies offering Internet services, is providing users with very attractive and low cost packages. The average Canadian ISP rates are about \$23/ month. Some ISPs monthly fees today are as low as \$9.00 to about \$30.0 depending on the amount of access time. Most ISPs today, offer the bonding option, where the rate is doubled to 128 Kbps. Such connections are usually tracked as double connection time, and therefore the cost is doubled. This option, however, is not common among individual users.

Table 6.2 summarizes the different cost elements of the Internet access using an ISDN line with Bell:

Table 6.2: Summary of costs of an ISDN connection

Cost Element	Total cost	Notes
Installation charges:	\$32	ISDN jack installation for 1 hour @ \$8/15 min. inside wiring
Terminal requirements	\$600	terminal adapter prices are \$400-800 software installation and configuration costs: \$50
Total start up costs:	\$632	
cost element	Total cost	Notes
access charges	\$51 to \$57 + x hours * hourly cost	cost components involve: Monthly fixed charge + usage charge of \$1.00/hr/channel with a cap of \$50/channel
Internet service provider	\$23	average ISP rates in Canada.
Total monthly charges:	access charge + ISP expenses	

Despite the high transmission rates ISDN is offering over standard analog modems, live interactive video-conferencing sessions can be very frustrating and can cause several bandwidth and network problems, especially when using new technologies such as the MBONE, and when the session heavily uses extra multimedia material and applications. Full motion video requires 1.5 Mbps using MPEG1 compression (Motion Pictures Expert Group), and 3 to 6 Mbps for improved quality using MPEG2. These required rates to deliver video, are far beyond basic rate ISDN data rates, and even transmittal of large graphics files is slow.

Taking into account ISDN's limitations, combined with the elevated demand for high speed access and broad bandwidth applications, telephone companies have been working on a more powerful, which can guarantee high quality transmission of full motion video, at affordable rates. This technology is ADSL.

6.2.3 ADSL: Asymmetric Digital Subscriber Line

ADSL is a recently developed modem technology, which uses the existing twisted pair telephone lines for multimedia and high speed and data communication delivery. As its name implies, ADSL transmits an asymmetric data stream, with a higher downstream flow-of up to 9 Mbps-than the upstream, which rates up to 640 Kbps. Unlike with ISDN or a dial up modem, ADSL users are constantly connected to the Net as long as the computer is on. Among other services such as video on demand, high speed Internet access is one of the principal services to be offered.

The first residential connections have already started in several test markets in the beginning of this year (1997). By mid 1997, most companies will be offering the technology in some of their service areas. It is not clear, yet, how much they'll charge for an ADSL line but it is anticipated that it will be more expensive than ISDN. Also, ADSL modems have been tested successfully by more than 30 telephone companies in North America and Europe.

As illustrated in Figure 6.6, an ADSL circuit connects a pair of ADSL modems on each end of a twisted-pair telephone line, one at the telephone company's central office and the other at the customer premises--over a standard telephone line. This circuit creates three frequency channels:

- A high speed downstream channel: ranging from 1.5 up to 9 Mbps, and
- A medium speed duplex channel: ranging from 16 Kbps to 640 Kbps.

Each one of these channels can be sub-multiplexed to form multiple, lower rate channels.

- and a POTS channel, which carries the regular telephone conversations. The POTS channel is separated from the digital modem by filters information channels, leaving POTS service independent and undisturbed, even if a premises ADSL modem fails.

Fig 6.6: Structure of the ADSL connection and data rate transmissions

The downstream data rates depend on a number of factors, including the distance between the user and the telephone company central office, the copper line size and the presence of bridged taps.

The following table gives the different ranges of downstream data rates depending on distance:

Table 6.3: Downstream ADSL data rates depending on distance

Data rate	Distance	Wire size
1.544 Mbps	up to 18,000 feet	0.5 mm
2.048 Mbps	16,000 feet	0.4 mm
6.312 Mbps	12,000 feet	0.5 mm
8.448 Mbps	9,000 feet	0.4 mm

Source: http://198.93.24.23/ADDL_Tutorial.html

Premises beyond these distances can be reached with fiber or copper Digital Loop Carrier Systems (DLCS). Telephone companies are convinced that they can offer ubiquitous ADSL access in a relatively short time.

Advantages of ADSL:

There are several benefits of the ADSL technology using the DMT (Discrete Multi-Tone) based modems. The following are some of these advantages :

- Service guarantee regardless of distance or loop: This is a very important feature to keep smooth and continuous communication, especially during on-line live lectures. The DMT-based modem will always connect. First, it attempts connection at the maximum rate (9 Mbps). If the line condition does not permit connection at this bandwidth, the DMT modem will then attempt to reestablish connection at successively lower data rates, until a solid connection is established. If no other connections are possible, it falls back to the lowest data rate, typically 1.5 Mbps. Thus, on-line lecture sessions are always assured continuous transmission. This represents a very advantageous and significant feature for on-line institutions, since high quality service would encourage more students to take on-line classes.

- Automatic evaluation of line capacity, without any service provider intervention: This is very beneficial since it reduces maintenance expenses. For example, in case a line over-saturates, DMT-modems alert the user's system, thus allowing it to take a more proactive approach to troubleshooting. Such automatic evaluations also can help in averting problems, thereby eliminating potential service lapses. As a result, the user can be always guaranteed service, despite the network problems.
- Security: DMT-based ADSL modems perform a considerable amount of handshaking during operation. As a result, it is extremely difficult for the signal to be received by any connection other than the targeted remote unit. The bit-loading key, which is only applicable to the two end modems, looks like jumbled noise, preventing it to be deciphered by intruders. As will be explained later in more details in chapter 8 "Internet security", security is a valuable requirement in a telelearning environment, to ensure fluent and appropriate transmission of the proper learning material. Being able to satisfy this fundamental requirement is a promising feature for ADSL to help increase its adoption rate.

Issues with ADSL:

Despite all its advantages, ADSL has a few problem areas which should to be entangled. First, similar to ISDN, ADSL users have to be located within a limited radius in order to receive high rate transmissions. The faster the data rate, the shorter the distance must be between the subscriber and the central office. In some cases, in order to receive the 9 Mbps rate, customers must be located less than 9000 feet from the central office. Even though this distance is greater than the maximum distance allowed by T1 lines (5000 feet), it is less than that for ISDN (18000 feet). While most customers usually lie within this radius, this condition can be a limiting factor for users in rural areas. Expensive upgrades, DLCs or repeaters would be required to enable ADSL access, which represent extra costs for both telephone companies and users.

In order to provide ADSL connection, phone companies should install ADSL equipment at both ends of the loop connecting the subscriber and the central office. Upgrading thousands of central offices is very time consuming. Until all central offices are upgraded, ISDN technology can catch on, and be as proficient as ADSL technology.

Another issue is the lack of standards. The two main ADSL modulation existing today, are Carrierless Amplitude Modulation (CAP) and Discrete Multi-Tone (DMT). The main difference lies in the modulation technique used. CAP considers the bandwidth as one big pipe through which as many data as possible are pumped. CAP speeds currently are: 1.5 Mbps downstream and 64 Kbps upstream. DMT, the newer scheme divides the total bandwidth into 256 channels that can handle faster speeds. The advantage is that data is directed

away from channels with too much traffic and is sent down clear transmission paths which in turn, provides high quality connections. DMT transmits at 6 Mbps downstream and 640 Kbps upstream.

If both technologies are proliferated, interoperability problems are prone to exist. Moreover, telephone companies costs can increase, since they will have to purchase and to maintain different pieces of equipment to provide seamless connectivity with other phone systems. Telephone companies would, therefore have to share the cost burden with end users, leading to high service charges. According to ADSL technology experts, DMT has a finer grain of rate adaptation and is more likely to be the ADSL standard. Moreover, DMT has been endorsed by the American National Standards Institute.

Provisioning costs, both for modems and central office equipment, is another major issue, which can significantly affect endusers' decision about the appropriate Internet access technology. Current ADSL modems costs make the service prohibitively expensive. At this time, the price per ADSL line is about \$3,000 to \$1,500 for the two modems and \$1,500 for installation, engineering, routers, and other services. These costs are expected to drop faster to about \$500 per line, as modem prices drop and telephone companies start buying more ADSL equipment in volume, especially when standards are set.

Costs for students:

ADSL products available in the market today, do not really give a precise idea about the expenses an ADSL user incurs. According to telephone companies, the desired future price for a pair of modem in the \$350 to \$500 range(compared to the present \$1,500 per modem pair). According to industry experts, improving chip designs, and higher volumes should help bring the modem prices down. The ultimate goal of many leading telephone companies, such as Ameritech, Bell South and Pacific Bell, is to offer ADSL-based Internet services in the \$35-to-\$50-per-month range. Based on these prospects, telelearners are very likely to adopt ADSL, by virtue of its high quality services plus their increasing bandwidth requirements.

ADSL modems have been tried by as many as 30 telephone companies and hundreds of lines have been installed in North America and Europe. Several telephone companies are planning for market trials, principally for video on demand for applications such as on-line telelearning, and high speed Internet access. Until now, no ISP has announced ADSL service yet, which makes it difficult for endusers to make exact predictions about ADSL's capabilities. Telephone companies, on the other hand are very optimistic about ADSL's potential and are expecting mass deployment by 1998-1999.

6.2.4 Cable modems:

Like telephone companies, cable companies are also at a transition stage from their traditional core business of entertainment video programming, to a position of a full service provider of high speed Internet access, and broad bandwidth applications, at affordable rates. In order to realize these objectives, cable companies have developed the cable modem technology.

A cable modem is a device, similar to the telephone modem, that connects a PC to a hybrid fiber/coax transmission system for high-speed data access (such as to the Internet) via cable TV (CATV). Figure 5.7 illustrates the different elements for an Internet connection using a cable modem:

Fig 6.7: Elements of an Internet connection using a cable modem

Figure 6.8, demonstrates the difference between the traditional setting using a regular telephone modem and that using the cable modem.

Fig 6.8 Difference in Internet connection using dial-up and cable modems

In the left figure, a standard twisted pair is serving the phone and the computer modem, while the coaxial cable is connected to the television set. The right figure portrays the cable modem connection, where the cable modem has two connections, one to the television set and the other to the computer (PC).

Similar to telephone modems, cable modems also modulate and demodulate signals. Cable modem operations, however, is much more complicated than that of telephone modems. A cable modem operates as a modem, a tuner, an encryption/decryption device, a network interface card, in addition to several other functions.

Similar to ADSL, cable modems send and receive data at two different rates with the downstream rate much higher than the upstream rates, as illustrated in Table 6.4.

Table 6.4: Sample cable modem speeds

Modem	Downstream *	Upstream
3Com	30 Mbps	2.6 Mbps
Bay Networks	10 Mbps	10 Mbps
Hewlett Packard	30 Mbps	10 Mbps
Hybrid Net	30 Mbps	3 Mbps
IBM	30 Mbps	512 Kbps
Toshiba	8 Mbps	2 Mbps
Zenith	4 Mbps or 500 Kbps	4 Mbps or 500 Kbps

Source: Cable DataCom News available at <http://cabledatacomnews.com/modems.htm>

* Modem speeds refer to peak burst rates. Actual throughput is limited by 10BaseT Ethernet connection to the PC and network traffic, as well as the subscriber's PC processing power and software configuration.

In the downstream, data is modulated and then placed on a 6 MHz channel, without disturbing the cable television video signals, and is converted to the Ethernet protocol for communication with the computer. There are several modulation schemes, but the most popular are Quadrature Phase Shift Keying or QPSK (up to about 10 Mbps) and Quadrature Amplitude Modulation (QAM) (up to about 30 Mbps).

In the upstream, or the reverse path, the cable modem takes the Ethernet packets and converts them to analog signals that flow back to the cable company head end. The equipment located at the cable head end, splits off the data signal, converts it to Ethernet packets and directs it to an Internet server. Voice conversations are also stripped off and routed to a local exchange switch.

Cable modem speeds vary widely depending on the modulation technique used. Asymmetric cable modem scheme is most common. In the downstream direction, i.e. from the network to the computer, transmission rates can reach 30 Mbps. However, only few computers can handle these rates. Considering that Ethernet (10bT) is the most popular cable modem interface standard for the PC, it limits the speed of connection to under 10 Mbps, even if the cable modem receives rates of 30 Mbps. For uploads, speeds can be up to 10-Mbps. Most modem producers, though, have selected a more optimum speed between 500 Kbps and 2.5 Mbps.

Mbps. Most modem producers, though, have selected a more optimum speed between 500 Kbps and 2.5 Mbps.

Cable modems advantages:

Cable modems provide very high-speed data transmissions, with downstream ranging from 500 Kbps to 30 Mbps, and upstream going from 96 Kbps to 10 Mbps, without interfering with the cable TV services. The high speed transmission rates will promote several broadband and time critical services to users, principally to the telelearning practitioners. Possible applications include:

- High-speed Internet access and fast high bandwidth applications.
- Audio and video-conferencing via the Internet and the cable, which provides very good opportunity to hold on-line audio/video live lectures and discussions;
- On-line access to educational resources such as educational video servers, local community information and services, and on-line libraries.

At this time, unlimited Internet access rates range between \$20 and \$50, a price which compares favorably with the rates currently charged by Internet access providers for 28.8 Kbps service over phone lines.

Several cable companies have already started commercial cable modem deployments. Cable DataCom News publisher Kinetic Strategies Inc., estimates that cable operators are offering two-way cable modem services to 2 million homes in North America in the first quarter of 1997.

Issues with cable modems:

Because of the cable networks' transmission technique and their original design, cable operators still have to resolve some problem are in order to meet the increasing demand for high bandwidth services.

The cable technology originally was designed to support the one way analog transmission of television programs to home. The underlying coaxial cable, however, has enough bandwidth to support two transport of signals. Hence, before they will be able to bring all the attractive high rate services, cable operators need to upgrade the technology, so that it supports bi-directional data transfers. Using the Internet, by clicking on web pages hyperlinks, or sending e-mail messages, requires the system to send the user's data request through the cable infrastructure and to receive the information that's sent back. To become interactive, cable operators must a locate spectrum on the cable for upstream signals.

Right now, several cable companies are upgrading their networks into a hybrid digital and analog systems, by transforming cable systems into hybrid fiber-coaxial or HFC networks. Systems are currently being

designed with fiber running out to nodes serving 500 and 2,000 homes. Many north American cable companies expect to complete the transition of their networks by 1998, while smaller metropolitan areas will be finished earlier than that. Several companies are applying different transitional approaches, until wide area cable interconnections and expanded Internet backbone networks are instituted. In many cases, information is stored locally or near the cable headend or regional hub to be accessed by users. Already several cable companies had held trials and have started delivering commercial services. The following table lists the different services in Canada.

Table 6.5: Cable modem service providers in Canada.

Cable co.	Location	Services	Vendors	Notes
Cogeco Cable	Quebec	commercial Internet services.	Zenith	services also available in Ontario
Rogers Cablesystems	Newmarket, Ontario	Commercial WAVE service offers unlimited Internet access for C\$39.95/month	Zenith	More than 800 paying subscribers, approx. 5% penetration of basic cable subs in suburban Toronto
Rogers Cablesystems	London and North York, Ontario.	Commercial WAVE service offers unlimited Internet access for C\$55/month	Zenith	Rogers has also launched WAVE in Brampton, Hamilton, Ottawa and Vancouver
Shaw Communications	Calgary and Toronto.	Commercial WAVE service offers unlimited Internet access for C\$55/month	Motorola	WAVE service offered under Canadian MSO alliance
Videotron	Montreal and Alberta.	Commercial launch of high-speed Internet service	Motorola	Montreal deployment includes InfiniT content service.

Source: <http://cabledatcomnews.com/trials.htm>

One other issue, is that cable modems on the same node share bandwidth, which means that congestion is created when too many people are on-line simultaneously. By way of illustration, if two telelearners living in the same neighborhood are downloading large graphic or multimedia file at the same time period, they can use up a significant portion of the shared bandwidth, and therefore slow each other's operations and their neighbors' access. Today most ISPs connect to the Internet using a T1(1.5 Mbps) telephone line, and all their subscribers share that pipeline. Cable headends connecting to the Internet backbone using a T1 limit users to a maximum of 1.5 Mbps.

In order to create an apparent faster network, and to eliminate network connections bottlenecks, many of the foremost cable companies in the cable modem field, are planning to store or "cache" the frequently requested web sites and Usenet groups on a local server at the users' neighborhood head end. The problem which might arise in this case, is when a user requests a file which does not reside on the headend server.

traditional analog phone lines. Cable operators, however are currently working on solving this problem by trying to expand their server' capacity.

One other issue is that, as the usage patterns and more high bandwidth real time applications such as video-conferencing via the Internet become more commonplace, guaranteed bandwidth becomes very important. With the different network bottlenecks, guaranteed bandwidth will likely be offered as a premium service. This means that it is only those who are willing to pay more will be guaranteed bandwidth. Guaranteed bandwidth, however, might also mean lower bandwidth. These conditions can discourage the on-line telelearning community from using cable and use other more convenient and may be cheaper techniques, such as high speed modems, in the short term and ADSL in the longer term.

If separate channels are allocated for upstream, data will be transmitted via low frequency band that hasn't previously carried a TV channel. This can create a "noisy" environment for cable modems, created by interference from HAM and CB radios and impulse noise from home appliances. Additionally, interference can be easily introduced in the home, due to loose connectors or poor cabling. Moreover, the tree and branch structure of cable networks tends to amplify the noise and to add it together as the signals travel upstream. On account of this problem, most manufacturers will use QPSK or a similar modulation scheme in the upstream direction, as it is more powerful than higher order modulation techniques in a noisy environment. The drawback is that QPSK is "slower" than QAM.

One other technical issue for cable operators, is that they will have to set up a community wide Internet point of presence (POP) to serve all the networks associated with a particular head end. This process requires high technical expertise and a thorough understanding of TCP/IP networking. In order to manage the Internet traffic, cable operators will have to set up routers and servers at the head end and at strategic places around the cable system to manage Internet traffic.

Another location issue, which can be very costly to solve is when the student's PC isn't near the TV or any cable plugs. In order to have Internet access via cable, the cable company will need to rewire the user's house and link the computer to the cable system, which can be very costly.

At this time, where the cable modem use is limited to Internet access, having an asymmetric service, with a much higher bandwidth allocated for downstream channel than the upstream is acceptable. Most of the common Internet applications today, tend to be asymmetric in nature. Downloading Web files, browsing the Internet resources and reading newsgroups send more data towards the user than to the network. On the other hand, uploads are generally limited to Mouse clicks (URL requests) and e-mail messages, which are not bandwidth intensive. This situation however, is changing as more bandwidth intensive applications are becoming prevalent. Within a telelearning environment, real time applications such as video and audio conferencing, and multimedia exchanges are very essential for an effective on-line delivery of the educational material.

Recently, industry engineers have been working on several alternative strategies for upgrading the upload bandwidth. Already, full two-way capability of the coaxial cable has been tested in several field tests, and is now being utilized in many areas. By the beginning of the second quarter of 1997, two way capable modems will be available in most cable systems.

One other concern regarding cable modems is user training. In order to ensure efficient use of the new tools, user training is essential. The required training and support to bring new users on-line can be overwhelming in terms of costs and volume. The fact that some leading ISPs, such as PSINet, have stopped providing inexpensive Internet access due to the demanding customer service requirements and dealing with inexperienced users, hints the extensive training and support that users will need. Cable modem proponents look upon this issue as a one time requirement, and do not consider it as a major issue.

Even though cable modem technology is still at an early stage, many cable modem vendors are already offering a wide selection of their products. The issue, however, is the lack of standards. Each manufacturer is using a different data-transmission specification, resulting in problems of incompatibility. If students decide to move to another city, they will need a new cable modem from the local cable operator, which represents extra costs. As illustrated in Figure 6.9 below, at both ends of the cable connection, the equipment at the customer premises and that at the cable company should be the same.

Fig 6.9: Required use of same vendor equipment at the cable company and the customer premises.

Standardization is underway, though. More vendors today, are cooperating on standardizing their tools to make them more compatible.

Costs for students:

With cable modem services becoming more commercially available, several cable operators have been trying to bring access charges down to encourage subscribers to use the technology, by offering high speed data service packages, much like they do for basic television service. At this time, charges vary between \$40 and \$60 per month for an Internet service package which includes software, unlimited Internet access, specialized content and a cable modem.

The costs involved with using a cable modem comprise the following:

- **Cable modem:** at this time (1996-1997), manufacturers are selling cable modem at around \$500. Prices are expected to drop to \$200 as sales volumes expand and standards emerge
- **Access Service :** during 1997 and the beginning of 1998, cable modems will not be sold in retail computer distribution channels. Instead, users will lease the modems from the cable company much as they do with cable converter boxes today. Estimates range from \$20 to \$50 per month for unlimited access time.
- **Installation:** Cable companies typically charge between \$50 and \$150 for hook up fees to get a user home configured for the Internet. The charge depends on whether the user's PC is configured for Ethernet or not and whether the home has already cable installed.

The table below summarizes the expenses of accessing the Internet using a cable modem:

Table 6.6: Summary of costs of an ADSL connection

Cost element	cost
Cable modem	\$500
Installation cost *	\$50
Initial costs	\$550
Access service	\$30
Monthly cost s	\$ 30

** Assuming the user has an installed cable and the PC is already configured for Ethernet.*

Cable modem technology is believed to be the dominant delivery mechanism for high-bandwidth Internet access. The long time frame required to install the infrastructure, however, makes other technologies such as ISDN and ADSL more competitive.

6.2.5 Comparative analysis of all Internet access options for telelearning student via the Internet:

Table : 6.7 Comparison of Internet access options

	Possible services	speed upload/ downloa d	Efficiency in a telelearning environment	Pros	Cons
Dial- in modems	Asynchronous and real time text based communication. - audio conferences. Text based file exchanges.	14.4-36 Kbps/ 14.4-36 Kbps	Very low for multimedia applications - Acceptable for asynchronous and low bandwidth real time interactions.	Affordable and widely available Permits several applications:(e-mail, text based conferencing, asynchronous multimedia communication)	Very slow and might cause in many cases interruption of an on-l session.
56 Kbps modem	High speed downloads. Video and audio conferencing	56 Kbps /56 Kbps	Good	Acceptable price, Does not need additional equipment. More convenient and cheaper than ISDN.	Lacks standards
ISDN	Fast downloads and uploads of large files. Audio and video-conferences.	56-128 Kbps/56 - 128 Kbps.	Good-very good	W widest availability; Mature technology and products.	Still not ubiquitous. Some of its services are costly. Hard to configure
ADSL	Faster downloads and uploads than ISDN. Audio and video-conferences. More effective application of high bandwidth technologies	16-640 Kbps/ 1.5-9 Mbps	Very good	Uses existing infrastructure Offers more services than ISDN. Permits continuous on-line access.	Still at trial stages. Won't be ubiquitous for years. Likely to be more expensive than ISDN.
Cable modems	Live audio and video-conferences. Very high speed uploads and downloads of multimedia files.	99.6 Kbps-10 Mbps/50 Kbps-30 Mbps.	Very good	Best price performance ratio. Standardization is starting.	Very time consuming network upgrades. Immature technology, a products. Won't be widely availab for years. Bandwidth shared with other users.

* Possible services for all technologies other than dial in modems, include those which are extra to the basic dial in modems possible applications.

Table 6.8 displays sample times for transferring data using existing and emerging technologies.

Table 6.8 : Sample transfer times of high speed technologies.

	File size (Mb)	Modem (14.4 Kbps)	ISDN * (56 Kbps)	ADSL (1.5 Mbps)	Cable modem (4 Mbps)
Simple image	2	2.3 min.	35.7 sec	1.3 sec	0.5 sec
Complex image	16	18.5 min.	4.8 min.	10.7 sec	4 sec
Short animation or video	72	1.4 hr	21.5 min.	48 sec	18 sec
Long animation or video	4320	3.5 days	21.4 hr.	48 min.	18 min.

* ISDN can transmit at twice this rate using two B channels.

Source: *ISDN-Internet Speed or digital Nightmare?*

<http://www.techweb.com/helper/thfeature/featureISDN4.html>

Conclusion:

By comparing the different technologies, it appears that on-line students are very likely to continue using the 28.8 Kbps modems for the time being (i.e. 1997), since as was shown by the different product tests, the difference in performance is not significant. As standards emerge for the 56 Kbps modems, it is anticipated that on-line students and instructors would shift to these faster tools. According to some market analysts, since 56 Kbps modems transmission rate is close to single channel ISDN(64 Kbps), and is more convenient and cheaper, competition is expected to arise, and the pace of ISDN deployment will slow down. Since most of the telelearning practitioners are price-sensitive customers, 56 Kbps modems might be more popular among telelearners than ISDN, only if ISDN prices drop at rates similar to that of modems.

As high bandwidth requirements for Internet -based telelearning operations increase, to include more video-conferencing and multimedia files transfer, ADSL and cable modem technologies are likely to become more prevalent. Depending on which one catches the market first, telelearning environment members would switch to these higher speed services.

According to some telecommunication analysts, if telephone companies can offer their service at prices similar to those of cable operators, with faster connections to the Internet backbone and better customer service, cable modems can face significant competition from ADSL. But until ADSL is deployed and as long as usage patterns do not change too much, the current access rate of 1.5 Mbps access through cable modems will be a very attractive solution for on-line students and instructors.

6.3 Tuition fees:

There are still no common rules for setting on-line courses tuition fees. With the increasing competition between on-line education providers, it is likely that tuition fees would drop. However, similarly to conventional institutions, a niche market with high tuition fees, designating “good-name” and high quality virtual institutions might also emerge. For the time being, fees range between two extremes. Except a few cases, many on-line academic institutions do not provide any justification or breakdown of their fees. This issue can in many cases confuse telelearners who might use the tuition fees as a basic criteria for making their decisions when choosing on-line program or course. Tuition fees however, do not always reflect the value of the program and the level and competency of the teaching staff, which might lead in some cases to costly and unfavorable results for telelearners.

Also, the lack of clear rules about setting tuition fees can be a discriminating factor against students who can't afford paying high tuition fees, but they wish to receive a high quality education, as their wealthier peers. Moreover, the international aspect of on-line courses, and the different life standards across the world are two main elements which should be considered when setting on-line programs tuition fees, since high prices can deprive those in countries with low standards of living from taking expensive courses.

CyberHigh, a Canadian-based virtual high school, offers credit courses for free and provides its students with the computer resources. The only charge a CyberHigh student has to pay is a CDN\$100 registration fee which breaks down to three parts:

- ➔ CDN\$50 for textbook rental. This is non-refundable to compensate for the costs of wear and tear of books.
- ➔ “CDN\$50 for computer maintenance and lease, since in order for (the students) insurance company to cover the computer on their home insurance, it may need to be a leased item”. This fee also pays for the computer at the end of the year.

Unlike CyberHigh, CyberEd, an on-line virtual university, charges for both its credit and non-credit courses. CyberEd students would have to pay \$437 for a graduate 3-credit course, \$365 for an undergraduate three-credit course, and \$135 for a non-credit courses. These fees include a \$68 processing fee for credit courses, and \$10 for non credit courses.

CALCampus, a service of the Computer Assisted Learning Center (CALC), is a virtual learning center offering courses to adults, high school and college students. According to Ms. Morabito, CALCampus director, the institution has "...set...prices low in order to allow everyone to participate, not just the wealthy". She adds that "In the US, (CALCampus) prices would be comparable to a community adult education center". Ms Morabito explains that CALCampus tuition fees are low because of its low operational costs, besides the low compensation rate of its instructors.

Table 6.9 provides a breakdown of the tuition fees of its CALCampus High School On-line Diploma. Charges for the required courses are the same as when the same course is taken separately.

Table 6.9 : Breakdown of CALCampus High School On-line Diploma fees.

Cost element	Cost(US\$)
CALCampus Student Admission	45
High School Diploma On-line Program Application:	20
Written Communication	49
Consumer Mathematics	49
Reading Comprehension	49
American History	49
Government & Voter Responsibility \$49	49
Law & Society	49
Graduation, Transcript, and American Academy Diploma	124
Total	\$483

Many on-line telelearning practitioners, such as Greg Stone a developer and instructor at CyberEd, argue that an on-line course does not cost less than an on-campus course. They claim that while telelearning via the Internet is cost effective in terms of reaching a wider range of students, and saving on computer facilities and buildings, it brings new costs not associated with traditional face to face courses. These costs include, among many others:

- The additional staff required for computer support and training of instructors and students.
- Time intensive development of on-line courses
- Extra need for assistance for handling assignments and tutorials when the class size is big.
- Copyright expenses for using copyrighted material.

Others, on the other hand believe that not all costs should be reflected in the tuition fees, since most of the expenses are one time costs. Moreover, the intense competition in this field would eventually cause rates to drop.

In order to solve this problem, an Internet board of education might solve this issue. The role of this "International board of education" would be to set criteria of setting tuition fees to all Internet courses. This can depend on the level of the course, type of the degree, the number of hours needed to finish the course, security costs and copyright charges. The charges however, should be within a certain range, which should be considered to be affordable by most international students. If not the benefits of worldwide access to high quality education might not be realized, since high tuition fees would be a discriminating factor against a certain number of students.

Setting a clear set of rules determining Internet on-line courses fees, would provide students with a clear idea about the different elements of the tuition they are paying and helps them evaluate the different available courses. Moreover, the intense price competition between institutions offering on-line courses and programs should be regulated, in order to provide a larger number of instructors and institutions with the opportunity of on-line instruction, and to permit more students benefit from the expertise of competent instructors.

6.4 Other costs:

These costs can include the following:

- Costs of textbooks and other required studying materials, provided by the instructor, from time to time. This is especially in case students are scattered all over the world, and for certain reasons such as copyright, they can only use a print copy of the material. Print material costs, however can be also included in the tuition fees.
- With the increasing digitization of learning material, and the progression towards solving Internet material copyright issues, students will have more flexible access to course material. A new cost element however, is likely to arise: the cost of accessing and using copyrighted material". This cost can be applied in many ways such as:
 - When requesting the material from the supplier, via Internet forms or using the traditional payment methods for better security.
 - Or by paying for a secret key or a password which allows the user to access the material whenever needed.

At this time, copyright charges are not yet applied, and therefore no clear costing criteria, are already set. It is expected though, that costs might be proportional to hard copies, such as in the case of books. Clear guidelines should be developed for pricing files with multiple sections of different copyrighted materials, in order to prevent any infringements.

- Charges for accessing the institution's internal campus Web site and courses material.
- Charges for using security tools such as passwords and encryption keys.
- ISP charges: today, with the increased competition between ISPs, users are offered several attractive packages at very cheap rates. As high speed Internet access technologies become more common, charges based on the amount of connection time would not be significant for ISPs. Instead, they might set charges which are based on the amount of data sent and received. This might initially, increase costs for students using high speed and broad bandwidth applications such as video-conferencing and downloading large multimedia large files. After all, intense completion, and the augmenting demand for broad bandwidth and the incessant development of high speed technologies, would ultimately drive bring rates down.

Chapter 7:

INSTITUTION RELATED COSTS

7.1 Introduction:

Most of the costs for partially and totally on-line institutions are the same. Hybrid organizations, which will be offering both conventional and on-line programs, or those which have replaced some of their conventional courses for Internet-based ones, are very likely to save on a certain number of cost elements, such as facilities, staff, and buildings maintenance. Some of the main cost savings elements are examined under section 7.2 “savings for partially on-line institutions”. On the other hand, offering courses on-line will also bring in a new set of cost elements, such as Web site construction, and on-line technical support. Other costs will be discussed in more detail under section 7.2; “Costs of establishing an Internet-based academic institution.

We note that under this section we assumed that costs for offering an on-line course whether by a totally or a partially on-line institutions are the same. Costs, which have been always incurred by partially on-line institutions will not be considered. These include costs such as computer labs, terminals, computer staff salaries, maintenance and accommodations costs.

7.2 Savings for partially on-line institutions:

Many academic institutions today, are starting to offer more Internet-based courses and programs, as a solution to their shrinking budget and the lower enrollment rates. At the same time, offering courses on-line can result in savings at many levels. Some of the costs elements where savings are likely to be realized include:

- **Facilities:** institutions will be saving on fewer facilities, such as new class buildings, offices, computer labs, facilities maintenance, heat, clean up and other accommodations, which are ongoing costs and increasing as the number of students increase.
- **Learning material expenses:** the easy digitization and the low costs of on-line publishing significantly lowers learning material costs. To illustrate, instructors at the VOU(Virtual On-line University), CALCampus and CyberEd write their own hypertext books on-line, which can later browsed by students for free.
- **Instructors expenses:** Even though this might not be a common saving for most of the virtual institutions, such as in case an instructor is offering an on campus and an on-line course, or if the institution takes into consideration the experience and the competency of its teachers, some institutions realize some savings on this elements. At CALCampus for instance, the instructors income is only from the tuition fees. Many of them are also teaching both in conventional classes. Therefore, they are not

totally financially dependent on on-line courses. concerning training, no expenses are incurred since it is the director and her faculty who train new instructors.

There will be one possible extra cost however, in case the institution decides to deliver its program using broad bandwidth live applications such as interactive video-conferencing using the MBONE:.. that is the cost of upgrading the connection lines to T1, T3.

Using a leased line might be a sound alternative for an institution which is planning to be continuously using high bandwidth. This technology offers very high quality and fast connections, reaching 45 Mbps. Unlike cable and satellite connections, leased lines are interactive. For high level institution such as universities many already have the facility, and therefore would not incur any extra costs..

The benefit of this upgrade will be shared by telelearners taking the course on-line and the on-campus students following traditional classes. The benefits of the upgrade however, might not be fully appreciated, in case the on-line students have low speed connections and can only receive low bandwidth applications such text, audio and asynchronous multimedia file retrieval.

One other point worth mentioning in case Internet connection is upgraded, is that the cost of line maintenance and line usage charges can outweigh many of the above mentioned savings.

7.3 Costs of establishing a virtual Internet based academic institution:

The main costs incurred when a program is launched on-line via the Internet are:

- Cost of planning and preparing the strategy and policies;
- Cost of constructing a web site;
- Cost of upgrading and developing the on-line programs;
- Teacher, tutors and support staff training;
- Computer software support staff costs;
- Maintenance and upgrade costs of computer servers as new technologies are developed;
- Instructors and tutors' compensation costs.

7.3.1 Planning and strategy design costs:

The costs of planning and designing the institution's strategy are mainly time costs. With the increase competition in the on-line education field, the institution's staff should spend a considerable amount of time on designing a comprehensive and sound strategy. Both administrative staff as well as instructors should be

actively involved in the design process. The plan should encompass elements such as: administration, pedagogy, finance, and marketing.

The following are some of the important activities which should be accomplished when designing the strategy:

- Formulate the institution's mission statement, the long term goals as well as the medium and short term objectives. These are very important prerequisites for any further action, in order to ensure conformity and consistency in everybody's objectives and work plans.
- Prepare a strategy plan for the server's operations. The plan should include all elements such as financial, marketing and long term strategies for raising funding resources and providing server users such as instructors and students with the appropriate services. For instance the team should decide on points such as:
 1. The type of environment for interaction:
 - Asynchronous vs. synchronous,
 - Real time text based only such as IRC, text based with hypermedia such as MUD and MOO environments, Web conferencing, or real time video-conferencing using CUSeeMe for instance.
 2. Level of security: use passwords, encryption using public and/or private keys, digital signatures, etc.
 3. Applications to support on-line interaction: Java, VRML, Shockwave, etc.
 4. Features to be included: tables, Web search engines, mailing list service, database management, animation, institution's logo and unique graphics, scanned images (color & greyscale), periodic updating and maintenance.
 5. Payment procedures: on-line vs. traditional methods such as Fax, regular mail, phone.
 6. If payments will be made on-line, then an on-line payment system and an on-line orders processing system should be designed.
 7. Plans for further uses of the server as a cash generator: by offering test web spaces, for instance or leasing out space for clients to have their own web pages.
- Form the team of people who will be working on the institution's server and Web pages maintenance and upgrades, and train them by an Internet specialist. To cite an instance, a programmer can be needed for the server programming and the integration of computer applications such as Java and VRML, while a graphic artist is responsible of the Web page design.
- Setting staff and instructors training schedules for mastering the on-line environment.

- For partially on-line institution, it is assumed that they already have an Internet connection and a LAN. New totally on-line institutions would have to carry out the following steps:

- Choose the line connection technology to access the Internet. Depending on their budgets and requirements, staff should make their decision while taking into consideration future operations, such as heavy multimedia real time applications. For partially on-line institutions as mentioned earlier, upgrades to the line might be required, especially when a heavy network traffic is anticipated.
- Acquire the necessary assistant devices for running the server. These include:
 - A DSU/CSU (Digital Service Unit or Channel Service Unit) to make the data suitable for the server, and a router. Each cost in the range of \$2000 to \$3000 .
 - Adapter cards for each computer terminal on the LAN (about \$100/card)
 - A hub connecting terminals to the server. Depending on their speed hub interface prices can range between \$200 (10 Mbps interfaces) up to \$1800 (100 interfaces).

These are some of the principal elements which should be determined before starting the program on-line. Once all of the strategy requirements are satisfied, and final decisions are made, the program can then be launched. Some on-line institutions, such as CyberHigh for instance, initiated the program for an experimental period. Based on the students and the faculty feedback, necessary changes and improvements are supplemented, after which a final work plan is set, and the program is then introduced to the open on-line telelearners community.

It is very important to note also, that the strategy should be periodically reviewed and updated, in order to ensure that all the activities are being accurately implemented and that all objectives are being achieved. In case the institution has a high speed access, faculty meetings could be held live on-line, in order to save on travel and time costs. On-line timely meetings perfectly suits crisis management situations, and adds flexibility to staff operations, which in turn can significantly increase the institution's efficiency and productivity.

7.3.2 Site construction Costs:

Any virtual or partially on-line university operating via the Internet counts on a big number of students and interested Internet users to access its site. Through a Web site, the institution can recruit students and faculty, provide campus wide information and provide research opportunities and access to wide information resources for insiders as well as outsiders. The way a Web page is designed can be a very

powerful tool which can be used to compete with other competent on-line institutions, especially if they are offering the same program.

Paying for a Web server is not a very costly element for institutions. For hybrid institutions, maintaining and running the Web server can be done by students and instructor's from the institution's computer department, and running the Web site can be even made part of the a computer course curriculum. Virtual institutions, on the other hand might need to hire specialized technicians.

The steps involved in a site construction involve:

1. **Setting up a test page:** It is recommended to set up a test page before establishing the official site. The institution can use someone else's server to be its test bed. Test Web pages can be put up for less than \$500 a year through hosting services. Besides, housing the institution's Web documents, the additional options which come with the hosting service package are very usually very useful and can help the institution in establishing itself in the Internet community. One such important service is the super high-end HTML self-store option, which helps making credit transactions. This option can be helpful to settle tuition payments of the first students who will be joining the institution.
2. **Hiring a Web specialist or Internet consultant:** The Web specialist role is very critical, since pitfalls due to inappropriate designs can be very costly, and can affect the institution's long term plan. The very basic role of an Internet consultant is to set up the server. However, consultants can be hired for a longer term to assist in managing the server building process, and to train those who will be responsible of the server maintenance, later.
3. **These days, short term Web specialist fees** range between \$60 and \$150 per hour, depending on the region where they are operating. While long term or general consultants' fees can be anywhere between \$750 to \$2000 depending primarily on the consultant's expertise.
4. **Choosing and registering a domain name** for the server with the InterNIC. InterNIC charges \$100 per domain plus a \$50 annual fee.
5. **Deciding on the hardware to be used for running the server:** at this time, Windows NT Internet information sever offers many Internet ready applications, and makes it an economical solution for running servers.

Table 7.1 summarizes the different site construction costs:

Table 7.1: Site construction costs

Site construction cost element	Notes
Test page web hosting	200 setup +\$50/month until the site is transferred to the institution's web server.
Web server	
Internet consultant or Web specialist	\$60 to \$150/hour depending on the region. Charges cover the institution and/or instructors web pages design.
Domain name registration	\$100 for the domain name + \$50 annual fee

7.3.3 Cost of upgrading and developing the on-line programs:

Based on a discussion held over the DEOS-L mailing list, instructors who plan to give an on-line course are in some cases provided with a grant to hire an assistant to help them in the preparation of the on-line courses. In other cases instructors willing to offer an on-line course receive a bonus for the extra time they spend on the development. Some participants mentioned that developing an on-line course for the first time is similar to starting a course from scratch. Based on their experiences, compared to face to face lectures, about two to three extra hours are required. This is mainly in view of the extensive time spent in writing HTML lectures, designing Web pages, searching and integrating the required links etc. Subsequent offerings and adjustments, however, are not as time consuming since on average they only need about an hour, for upgrades and updates.

7.3.4 Teacher, tutors and support staff training:

Training sessions for teachers, tutors and support staff should be done on a periodic basis, especially with the rapid technological developments in the Internet field. With virtual educational institutions providing international education, it is very likely that the teaching staff would be scattered in different parts of the world. Grouping all the staff in one location to be trained, would therefore represent an exorbitant cost, especially if the institution's budget is modest. On-line training would be the most cost efficient, highly flexible and productive method to ensure that all the staff are receiving the same message, and that they are always kept up to date with any environmental changes. This type of training is in itself a telelearning application.

One other cost which can not be avoided is the trainers' charges. Trainers' expenses usually depend on their expertise, experience and number of training hours. They also vary widely from one region to another.

7.3.5 Computer software support staff costs:

Computer software staff should be omnipresent with the administrative staff and should be always available on-line in order to provide support for instructors and students while they are using computing resources. They usually have an e-mail address on the institution's main Web page, where they can be contacted whenever that is necessary.

7.3.6 Maintenance and upgrade costs of computer servers and other hardware:

These costs can be very high especially when the server needs to be changed. However, this costs is not incurred as frequently as upgrades. Hardware upgrades and improvements can be very frequent and at no fixed schedule, on account of the rapid technological advances. Maintenance costs, therefore can vary widely from one period to another, depending on the number of upgrades needed.

7.3.7 Instructors and tutors' compensation costs:

There are no exact guidelines for how payments of on-line instructors should be made. For instance they can depend on the number of students taking the course, the number of on-line hours, the number of courses they give, etc. Once on-line teaching becomes more common place, we could expect more clear guidelines to be set in order to protect on-line instructors and tutors rights.

Table 7.2 summarizes the different costs and their nature: periodic, one time costs:

Table 7.2: Summary of institution related costs

Cost element	Cost nature
Cost of strategy planning	big initial time investment shorter periodic review sessions
Cost of the web site construction	
Test page web hosting	initial one time setup cost + periodic monthly costs until the site is transferred to the institution's web server.
Web server	one time cost
Internet consultant or Web specialist	one time cost
Domain name registration	one time cost for domain name registration + periodic annual fee
Cost of developing on-line programs	one time cost
Teacher, tutors and support staff training	periodic
Computer software support staff costs	periodic
Maintenance and computing resources upgrades	periodic
Instructors and tutors' compensation costs	periodic

7.4 Problems with establishing a business case:

Even though several costs are involved when establishing an Internet-based telelearning program or course, it was not possible to establish a business case. The main reason being that these cost elements in many cases do not represent any significant dollar figures. After interviewing several institutions, some of which are virtual such as CALCampus, CyberEd, CyberHigh, Virtual On-line University and Diversity University, University of Colorado On-line, and others which are partially on-line, such as CSU, which offers a set of its programs on-line such as BBA, MBA and DBA, the Ontario Institute of Studies in Education and the Canadian Union of Public Employees, the main conclusion was that:

For totally on-line institutions, most of the costs are start up costs and are incurred once. On-going costs such as server maintenance and instructors' fees, on the other hand are in most cases much lower than those of conventional institutions. For instance, in CALCampus costs include: computer hardware that the administrative staff use, the Internet connection and server software. Instructors at CALCampus are part-timers, and are paid on a per student basis from the income from the students' fees. According to CALCampus' director: "(CALCampus) teachers do not make lot of money. They are teaching because they love to teach, they enjoy the on-line medium, and they enjoy their students...Our benefits are intangible, such as satisfaction from a job well done." There are no related training costs, as it is the institution's teachers and the director herself who train new instructors.

At other institutions such as CyberEd which is a department of the University of Massachusetts, Dartmouth, instructors teach both on-line and in conventional classes. Those teaching credit courses are compensated exactly the same as they are for teaching in a face to face UMass course. Instructors teaching non-credit courses, on the other hand, are paid on a per-student basis, with the number of students not exceeding 25 in any CyberEd class. According to CyberEd's coordinator, it is difficult to assess the costs related to operating CyberEd, since many of the faculty and administrative staff are continuously contributing to upgrade CyberEd's environment from their own time. Moreover, many of CyberEd's developments are used to supplement UMass' conventional classes.

At Central State University On-line programs department, John M. Anderson, the department's vice president points that "(CSU) maintains a pool of highly competent adjunct professors whom (they) can hire at a rate which doesn't include normal perks supplied for full-time professors", which means that the institution saves considerably on the instructors costs.

With regard to hybrid institutions, i.e. those offering both conventional and on-line courses, there are no costs related to equipment, facilities or Internet connection, since these resources are being shared between the different network's applications. As a result, adding one or a set of on-line courses won't add any extra costs.

Concerning the instructors costs, payment policies differ from one institution to another. In many cases, instructors are not paid any extra money for the on-line course, especially when they are already offering the same course within the conventional settings i.e. the course is offered both for on campus and on-line students. In other cases, an instructor is provided with a grant to hire an assistant for the process of transferring the course on-line. Based on a DEOS-L discussion concerning this issue, many instructors transferred their courses on-line using their own time and did not receive any extra compensation for that. In other cases, especially when the course is offered just on-line, instructors are paid on a per student basis or they are paid in the same way as other professors offering a face to face to course. It is important to note though that many instructors, especially those offering individual non-credit courses, are giving on-line courses in order to improve their computer literacy, and/or to experiment the Internet tools and their effectiveness in delivering education. Many others are just doing it for the sake of teaching and in order to provide knowledge for those who might not be able to acquire it otherwise. This is why it is very common that on-line instructors are either part-timers receiving minimum compensation or are just offering the course for free.

CONCLUSION:

Setting and taking part in an Internet based telelearning program, is a very cost effective alternative to face-to-face learning, both for the educational institution's administrative and pedagogic staff, as well as for students.

Dropping computer equipment prices, along with the increased availability of affordable Internet access options can be very encouraging factors for students, when taking an on-line course. Tuition fees, however, which vary considerably between institutions can rise their bill considerably, especially that some virtual institutions are charging in some cases the same fees as their on campus students. The rising competition however, might bring down this cost element, but it might not be the case also as it is the case for traditional institutions. Moreover, many students might still prefer telelearning via the Internet mainly because of the flexibility it offers.

When it comes to institutions, it is certainly the best alternative for delivering education, while making big savings on costs such as buildings expenses, especially with the shrinking budgets and the reduced federal funding. Even start up costs, such as site construction, and equipment expenses are one time costs and are also continuously dropping in prices. Costs such as training, computer maintenance and compensation costs, should be well managed and new methods which can bring such costs down should be investigated. A case in point is to hold training sessions via the Internet instead of bringing in all trainees to a common site, in which case travel and accommodation expenses can be very costly.

Part IV: ISSUES WITH TELELEARNING VIA THE INTERNET

Chapter 8 : Internet Security.

Chapter 9 : Policy issues.

INTRODUCTION:

Despite all its numerous benefits, and like any other technology expanding at an expeditious pace, the Internet still has several issues, which should be resolved soon, if most of the expectations of a universal effective and successful telelearning environment are to be realized. Fortunately, most of these issues have been recognized and are being tackled.

Among these various problems, we focused in this section on those which can significantly affect an Internet-based telelearning setting, and can influence the potency of its operations together with the value of its delivered material. The issues we examined comprise, first, security and privacy, which is discussed in Chapter 8, and is considered to be among the primary discouraging factor for some competent academic institutions to go on-line, as was discussed in part 2 “Current implementations”, such as the case of Harvard and Stanford universities.

Next, we have examined in Chapter 9, some prominent policy issues, which include: electronic documents copyright, accreditation of virtual academic institutions, on-line academic fraud and evaluation of the Web site’s content and creator.

In each chapter, a discussion is first provided about how the problem relates to Internet-based telelearning. Next, some of the solutions to solve these issues are suggested.

Chapter 8:

INTERNET SECURITY

8.1 Introduction:

Security management over the Internet is a growing challenge, primarily because of the open hierarchy of this universal network, and the expanding connectivity which can get easily out of control. Experts say that the capabilities of security products are still lagging behind those of other Internet products. If the promise of the Internet of a persisting and secure environment is to be fully realized, it is important to provide users with a secure environment, and to assure them that the information they transmit is not susceptible to fraud, copying, damaging or any other misuse by intruders.

In this chapter the emphasis is mainly on network technical security. Other security related issues such as academic fraud, copyright, accreditation and evaluation of the Web sites' content, were classified under policy issues and will be discussed later in Chapter 9.

When operating within a telelearning environment via the Internet, security becomes a very fundamental requirement, especially in certain cases, such as:

- Sharing sensitive information in group works and projects. This can be either in text, audio, or even video format.
- Carrying on lectures and class discussions for registered students only.
- Submission of tests and assignments .
- Making on-line tests and quizzes.
- On-line tuition fees and other charges payments.

In order to ensure an effective safe, private and secure environment, Internet-based telelearning academic organizations should satisfy the following elements of security:

Access control: That is ensuring that the course materials are only accessible to registered students, and authorized faculty. This would limit access to the institution's Web server and protect internal information from outsiders.

Authentication: that is ensuring that the senders of on-line documents at the other end of the session are really who they claim to be. When students take on-line exams, for instance, teachers need to be sure that the exam papers really do come from their students. This requirement can be difficult to satisfy, especially in case passwords are used as a security measure. Any one who intentionally or unintentionally gains access to the password can use it pretending that it is the password's owner who is sending the message.

This is why more sophisticated and safer methods should be used as will be discussed in the coming sections.

Integrity: That is assuring that the received information is the same as when it was sent and that no modifications were introduced. This is an essential requirement for on-line classes, especially during exams and sending multimedia documents which should not be altered.

Accountability: That is assuring that any transaction that takes place between the two or multiple ends of a session can be proved to have taken place. When students pay their fees, both the school administration and students should agree that the exchange took place. Also, when telelearners receive their diploma from their on-line institutions to use it later to find a job, they will need to be able to prove that it was really signed by the dean(authentication) and that they really received it (accountability).

Privacy: That is assuring that any sensitive information is kept private, and that is not visible to eavesdroppers. This requirement is very important while receiving exam papers, where information should be protected from cheating and alterations during transmission.

8.2 Security over the Web :

Putting a WWW server for a course or a virtual academic institution over the Internet, implies inviting telelearners and other interested Internet users to access the server, browse information and ask questions. Exposure of the institution's database and internal information resources, however, should be limited to certain authorized individuals, such as registered students and staff. In order to protect the institution's server from outside attacks and eavesdroppers, sound and reliable security administration and firewalls should be implemented.

The nature of the Web makes it very vulnerable to hackers' attacks. The WWW consists of two superimposed networks: a data communication network, which is the Internet, and an application layer network. The data communication network is a collection of several networks linked by routing networks. the distributed structure of this network increases risks of eavesdropping while transmitting information. The application layer network consists of servers and clients scattered around the Internet, exchanging HTTP files. HTTP files can imbed different types of data(graphics, sound, text, etc.). On the browser, each data type is associated with a presentation program called a viewer. These programs are often large and complex, which increases the risk of spreading bugs and viruses. Moreover, some of the file formats, such as Postscript, contain some programmability. As a result, a hacker can use these features to execute programs or to install data on the client machine.

For each layer some mechanisms have been developed in order to provide a safe and secure environment.

8.2.1 Security at the application layer:

In the application layer, the following two mechanisms are being applied:

The WWW basic security mechanism:

This mechanism is also referred to as basic authentication. Basic authentication is a system that uses IDs and passwords to apply access control to documents and files in a server. Under this mechanism, a client can only access a server if it provides a valid ID and password. The server, therefore, can identify who the client user is by means of the provided information. Almost all virtual telelearning institutions operating using different Internet tools, such as IRC, MUDs, MOOs or Web conferencing, use passwords as a means of limiting access to their information resources and servers. To illustrate, on-line institutions such as CyberEd, Diversity University, and CyberHigh, use passwords to limit open public access to their lectures sessions. On the other hand, main home pages, which include general information about the organization, contact addresses, public areas access such as student lounges and information desks are open for public access.

Even though basic authentication is widely use by almost all Internet conferencing applications, such as Web conferencing, MUDs and MOOs, it is not a reliable security mechanism to ensure user authentication.

The following cases prove the vulnerability of basic authentication:

- Students can deliberately give their passwords to another person.
- Someone might guess the password, and use it to access private areas.
- Someone might be using a password without the knowledge of its owner.
- Someone might catch the ID between the client and the server.

The three first problems are very common with any password system, even non Internet-based ones. Strict security rules and better user education can limit these problems, but are very unlikely to eliminate them.

The last case for instance depends on the level of protection given to messages by the HTTP protocol. The stateless nature of this protocol does not allow the server to retain knowledge about the client once the document is served. Consequently, the client has to provide the password every time a document is needed, in which case offers hackers are offered more chances to capture the password. Several browsers are circumventing this problem today, by sending the ID and password in all subsequent requests for the same server. Even though this method reduces the number of messages sent, it still allows hackers setting up a listening point to a busy server, to capture a stream of passwords.

The real solution for the fragility of basic authentication is to use encryption-based mechanisms.

Encryption-based mechanisms:

These systems provide various levels of security including: authentication, integrity, accountability and privacy, by applying cryptography to the connection. Several cryptography protocols, with different objectives, have been developed for securing the Web. Although none of these protocols is a complete standard some are widely used. Two of the most popular protocols are Secure Socket Layer protocol (SSL), which is being used by Netscape Navigator, and the Secure Hypertext Transfer Protocol (SHTTP). Both protocols use a combination of several cryptographic techniques in order to satisfy most of the security objectives.

The following section describes the three common cryptographic techniques used by these protocols to perform their tasks, which are symmetric key encryption, public key encryption as secure hash functions which used primarily for digital signatures.

Cryptographic techniques:

Symmetric key encryption:

Symmetric key encryption or secret key encryption is a cryptographic technique where the two parties share a secret key. Data are encrypted and decrypted using the same key. As shown in figure 8.1 below, the sender encrypts data using the key. Once transmitted, the receiver should use the same key to interpret the message.

Fig 8.1: Symmetric key encryption stages

The main problem with secret key cryptography is getting the sender and the receiver to agree on the secret key safely, without anyone else finding out. If they are in separate physical locations, as is the case for telelearning class members, who are likely to be scattered in several remote areas, they must use a trust courier, or a phone system, or some other transmission medium, to prevent the disclosure of the secret key being communicated. By overhearing or intercepting the key in transit, an eavesdropper can later use the key to read, modify, and reconstruct all messages encrypted or authenticated with that key.

Key management, which includes the generation, transmission and storage of keys, is very critical in an open system such as Internet-based telelearning settings. Because all keys in a secret-key crypto-system must remain secret, secret-key cryptography often has difficulty providing safe key management. Having the instructor managing the keys helps minimizing security risks, since they will be under the supervision of a trusted high-authority. We should note though that for telelearning settings, public-key cryptography system would be more suitable as will be discussed under section 8.2.1.3.2 Public-key cryptography..

Two of the commonly used symmetric key algorithms are: DES and IDEA.

DES, standing for Data Encryption Standard, is a standardized algorithm and is being used worldwide especially in the financial industry and by several governments. Despite its popularity, its short 56-bits key feature, makes it fairly easy to break with modern computers or special hardware. New variants of DES- such as Triple DES or 3DES, which uses DES three times with different unrelated keys-are providing a higher level of security.

IDEA (International Data Encryption Algorithm) is another symmetric key algorithm which is also implemented worldwide especially in Europe. IDEA uses a 128 bit key, and is generally considered to be very secure.

Public-key encryption:

This encryption system was introduced in order to solve symmetric key encryption key management problems. Instead of having one shared key, users have a pair of keys: a private key, known only by its user, and a public key made publicly available. Each person's public key is known by all other users, while the private key is kept secret.

This technique provides both: privacy and authentication.

- **Privacy** : since the information can be only interpreted by the private key. Users do not need anymore to share any private information over different communication media, which can be aimed to spying. All message interchanges only involve public keys, which are associated with their owners in a trusted (or authenticated) way, such as a directory. When a user sends a confidential message, he/she uses the public key. Once received, the message can only be decrypted using the receiver's secret key.
- **Authentication**: this achieved by having the message signed electronically by the sender's digital signature. Compared to a handwritten signature, a digital signature asserts the contents of a message,

as well as the identity of the user. Digital signatures will be described in more details under “secure hash functions”.

Figure 8.2 illustrates the different steps of public key encryption

Fig 8.2: Public key encryption stages

Public-key encryption provides its users with several advantages over symmetric-key cryptography. The primary advantage is increased security and convenience, by eliminating the need of private exchanges of secret keys.

One example of the most commonly used public key algorithms is RSA (Rivest-Shamir-Adelman) which can be used both for encryption and for signing. It is generally considered to be secure when sufficiently long keys are used (512 bits is insecure, 768 bits is moderately secure, and 1024 bits is good). RSA is currently the most important public key algorithm, however it is becoming more and more vulnerable to new types of attacks. RSA is patented in the United States (expires year 2000), and free elsewhere.

Another major advantage of public-key systems is authentication, a basic requirement for telelearning settings. The fact that a user can sign a message digitally is critical in assuring that the message is from who claims to be the sender and that only the intended receiver can read it, while keeping the information about his private key safe and secret. Authentication under symmetric-key systems, on the other hand, requires the sharing of some secret information, which can violate the security objectives.

One disadvantage of using public key cryptography for encryption is speed. Several symmetric key encryption methods are significantly faster than any currently available public-key encryption mechanism. In order to get the best of both methods, public key cryptography can be combined with symmetric key cryptography. For instance, the public key system can be used to encrypt a secret key used to encrypt the message. When receiving the message, the user first, decrypts the secret key using his private key, then uses the secret key to decrypt the message itself. This combines the high speed advantage of the symmetric system with the key-management convenience of public-key cryptography.

Another main issue with public-key crypto-systems is key management. Typically, it is the key owners responsibility to create their public and private keys. Since it is the user that generates the key pair, one of the problems is how can a recipient be sure that the public key claimed to be from the intended recipient is not that of an enemy pretending to be the recipient. All public key cryptographic protocols use what security experts call the idea of "Web of Trust". Anyone generating a public key is advised to have it signed by a number of other trustworthy people who are in effect affirming that the key belongs to the one it claims to belong to. Thus, the hope is that at least one of the signers is someone known to the sender as a trustworthy person, or that he is someone vouched for by a known trustworthy person.

Within a telelearning environment, the instructors can represent the third trustworthy party. One way to solve the issue can be by creating and maintaining a repository of all the students' public keys. Students therefore, can refer to that repository when they need to decrypt incoming messages from their peers, while assured that the key really belongs to who it is claimed for.

The problem recurs, however, when the repository members receive messages from outsiders, such as students and instructors from other schools and countries. One partial solution is to use the Web based public key repositories provided by some security organizations or by an international key retrieval systems, such as Four 11 which offers a White Pages e-mail directory including certified PGP keys.

Another alternative process to avoid problems with trust is to have a commercial company, called a Certifying Authority(CA), sign the public key as belonging to the person or company claiming the key. Certifying authorities can be commercial or government organizations. Momentarily, the only accepted CA is Verisign Inc., a branch of RSA data Security Inc. which used to directly issue certificates. The issued certificate tells the receiver that the certifying authority vouches for the fact that the public key really belongs to the sender identified on the certificate. This allows users to use public keys with confidence, as long as the certifying authority is trustworthy.

Certificates issued by CAs can be very advantageous for Internet-based telelearning settings, primarily for official or legal documents exchanges between the virtual institution and telelearners. Also, students might need such a secure service when acquiring non published, or any other form of important data from business or government organizations, for term projects and papers.

To sign a certificate, the certifying commercial company demands documentation demonstrating the relation of the user of the key to the claimed person using the key. This has the advantage of establishing trust and reliability of message exchanges, but its drawback is that the cost is high (of the order of \$300). For extra security purposes, digital certificates are only valid for a limited time. This means that certifying digital certificates commercially is an periodic and increasing cost. For an Internet-based telelearning setting, it is the virtual institution which would need a commercial service for their digital keys certification, especially if it was willing to deliver legal and sensitive documents on-line such as electronic degrees. Students on the other hand, are very likely to use the cheaper and simpler encryption methods.

Secure hash functions:

A secure hash function is another cryptographic method, which complements the two previously discussed cryptographic systems by fulfilling the remaining security elements: integrity and accountability. The main role of a cryptographic hash function is to provide digital signatures. This function is of great value to telelearners as it permits private messages, such as in the case of exams and teacher-student feedback, to be exchanged, while assuring that the receiver (telelearner or instructor) about the identity of the sender.

Digital signatures are used to check for any forgery or tampering, and to assert the identity of the sender. Digital signatures is an encryption of the message using the sender's private key. To add a digital signature, the security program generates a mathematical "summary" of the message, called a hash or a digest, encrypts the hash with the sender's private key, and transmits the sender's public key along with the message. On the other end, the recipient verifies the signature by decrypting the hash using the sender's public key. If the hash is still a true summary of the message, then the message has arrived intact. If verification fails, that hints that the message might have been altered while transmission, or the signature is falsified. It is sometimes difficult, however to determine whether there was an attempted fraudulence or simply a transmission error.

In order to verify the identity of the sender, the security program encrypts the public key of the sender with the private key of a third party and sends this "signature" along with the encrypted message. In case of an on-line class, students can use the instructor's private key. But in case the third party is not trusted, certified public keys could be used. As was discussed under "Public key encryption", hash function digests can be made public without revealing the contents of the document from which it is derived.

One of the commonly used message digest algorithms is MD(Message Digest), and its versions: MD2, MD4 and MD5(MD stands for Message Digest). MD5 is the most commonly used version. MD* algorithms are used for digital signature applications where a large message is hashed before being signed with the private key. All three algorithms generate a 128-bit digest from any length of input message.

The SSL protocol:

The SSL protocol provides server authentication, data encryption, and message integrity. SSL is layered beneath application protocols, such as HTTP, Telnet, FTP, Gopher and NNTP and above the connection protocol TCP/IP. The benefit of such structure is that it allows SSL to operate independently of the Internet application protocols. Moreover, by implementing SSL on both the client and the server site, the data is transmitted in encrypted form to ensure privacy.

A user can tell whether a document comes from a secure server if the document's location field (URL) starts with `https://` instead of `http://`. Also this can be known by looking at the door key at the bottom of the Netscape window. The icon consists of door-key on a blue background to show secure documents and a broken key on a gray background to show insecure documents.

The version of SSL that is exportable from the US is restricted to 40 bit keys. This implies that it is very likely to be broken by anyone with access to a reasonable amount of computing power, such students in a computer department. In a report issued in January 1996, Whitfield Diffie, the inventor of public key cryptography, stated that a minimum of 75 bits was necessary for "adequate protection against the most serious threats". An improved more secure implementation of SSL, called SSLeay, which was developed in Australia and is freely available and is being used by several WWW servers.

In general SSL is among the most supported security protocols despite some of its limitations, and the availability of more flexible protocols such as SHTTP, which will be examined in the following paragraph. This popularity can be contributed primarily to the strong position of Netscape in the market place.

The SHTTP protocol:

SHTTP is a secure variant of http developed by Enterprise Integration Technologies (EIT). SHTTP uses a modified version of HTTP clients and server to general purpose session and transaction security services, which include confidentiality, authentication, message integrity and non-repudiability of origin. It supports end-to-end security by incorporating cryptography to messages at the application level. This is contrary to the HTTP authorization mechanisms which require the client to attempt access and be denied before the

security system is applied. SHTTP incorporates public key cryptography from RSA Data Security in addition to supporting traditional shared-secret (password).

SHTTP cryptographic features used are: the symmetric key encryption for encrypting data, public key encryption to ensure privacy and authentication of the transmitted data, and the hashing functions for ensuring integrity and authentication. Depending on the user's security needs, any combination of these three options can be used.

SHTTP users deem SHTTP to be more flexible than SSL in many cases. One main advantage of SHTTP over SSL is its ability to perform client authentication. This allows for secure client/server sessions to be established. The fact that it requires the use of a certified public key, however, limits the degree to which it may be applied.

Remark: It is important to note that many of the new WWW developments can bring in new vulnerabilities to this medium. For instance, the Java, the VRML, and the multimedia web conferencing operations involve heavy use of graphics, audio and video. These applications can encumber the existing encryption systems and can lead to attempts to circumvent security features in order to maintain real time throughput, such as during a real time on-line class lecture. Generally, since any new technology or feature is likely to be vulnerable to security attacks when it is first introduced, early adopters should always watch for such risks.

8.2.2 Security at the IP network layer:

Within a telelearning environment, virtual on-line educational institutions are usually open to public access for students and guest visitors to consult the available courses and services. The more traffic and the more services are running through the server, the higher is the risk of ending up with security problems.

Besides the different security techniques applied at the application level, these precautions are worthless if there is no protection at the lower network level. One common security control tool is the network firewall. Firewalls provide security at the network level by acting as a guard against any untrusted traffic, and by monitoring and controlling the flow of information between the Internet and the institution's network.

An Internet firewall is a system or a hybrid of systems that enforces access control policy between a private network and the Internet. It usually combines a pair of mechanisms: one to block traffic and another to permit it.

Generally, firewalls are configured to support authentication mechanisms in order to ensure that only authorized users can log into the protected resources, which is very important in hampering intruders from accessing any unauthorized material. More sophisticated firewalls block traffic from the outside to the inside, but permit users on the inside to communicate freely with the outside. Some even act as very effective auditing tools. Their main functions are: to maintain internal information about the state of connections passing through them and the contents of some of the data streams, and to provide summaries to the administrator about what kinds and amount of traffic passed through it and how many attempts there were to break into it.

The main elements of a firewall are:

- **The screening or filtering router:** a screening router is a basic component of most firewalls. It can be a commercial router or a host-based router with some kind of packet filtering capability. Screening routers, typically are able to block traffic between the private network and the Internet, and disable any TCP/IP direct forwarding to the private network. Some firewalls, simply consist of a screening host between the two networks.
- **The bastion host:** the bastion is the most critical element of the firewall. It is usually on the private network and is the only reachable point by the Internet.

There are several firewall configurations which can be applied to secure private networks. The most secure configuration is the screened host gateway. In addition to the high security level it provides, screened host gateway is easy to implement. A bastion host is configured on the private network, with a screening router between the Internet and the private network, which only permits Internet access to the bastion host. Since the bastion host is on the private network, problems with external routing configurations are obstructed. The zone of risk in a screened gateway is restricted to the bastion host, and the screening router. Figure 8.3 portrays the screening host gateway

Fig 8.3 : Firewall operations between the local network and the Internet

Despite their useful characteristics, firewalls still have several shortcomings which need to be worked on. Even though firewalls are increasingly deployed and constantly proliferating, no new consequential developments in other aspects of security have been added. Analysts believe that, to be effective, a firewall must be integrated with other technologies such as digital certificates and cryptography methods. Other problem areas include the following:

- A firewall can't protect the network from internal users misbehaviors and attacks that don't go through the firewall. Inside threats can be as damaging to the network as external attackers. Inside users can steal, damage and copy data, actions that a firewall can't detect. A firewall must be a part of a consistent overall organizational security architecture. User education and internal security measures are very important in this case in order to limit similar problems.
- A firewall can't protect against new types of threats. With the incessant discoveries of hacking techniques, a firewall can't be expected to protect the network forever.
- A firewall can't protect against viruses. Although firewalls can control the incoming traffic, the scanning is mostly for source and destination addresses, not for the details of the data. Even though filtering methods are becoming more sophisticated, the various ways of encoding binary files for transfer over networks, the numerous architectures and too many viruses, and the use of different ways to hide data, significantly lower the efficiency of the firewall.
- The increasing number of new types of viruses, and methods a virus can use to hide data, significantly lower the efficiency of firewalls.

The level of expertise required to install and maintain a firewall, depend on the services provided, the platform used, and the institution's security concerns. Most of the firewalls available these days, are very practical as they require basic Internet skills to obtain the tools and basic administration skills to configure, compile and install them. A dedicated staff member or staff member might be required for the continuous maintenance of the tool, in which case an extra cost will be incurred by the institution.

8.2 E-mail security

E-mail is the most prevalent and important component of Internet traffic. E-mail sent over the Internet is more like paper mail on a postcard than mail in a sealed envelope. It can easily be read, or even altered, by hackers who can read and/or forge the transmitted messages. Its high popularity and easy use makes it vulnerable to such attacks. Securing e-mail, therefore, is a very critical requirement for safe message transmissions.

Several protocols and encryption systems have been developed in order to fulfill the enhanced security requirement. These include mainly: PGP, PEM and MOSS. Many of these systems were also used for other Internet applications such as file encryption.

All of the e-mail encryption systems available today, provide the following common features, which are fundamental for a telelearning environment . These include:

- **Sender authentication :** which ensures the instructor that the received message(which can be a paper, a test, etc.)is truly from the student who claims to have sent it. Sender authentication is provided by digital signature. Validation of the sender is also important for students especially when receiving important class material from their instructor, or personal feedback.
- **Message integrity:** which ensures that the message has not been altered in an unauthorized manner. This is also critical for similar situations as in the case of authentication.
- **Non-repudiation of origin:** where the originator(either the telelearner or the instructor) can not deny having sent the message.
- **Message confidentiality:** which ensures that the message is protected against tampering or disclosure to unauthorized individuals. This is realized by encrypting the message using symmetric or asymmetric(public key)cryptography algorithms. This feature is very important for telelearning practitioners, mainly for on-line submission of tests and papers, which must be protected from any cheating or tampering attempts.

Despite their security capabilities, each of these protocols still has some inadequacy which limit their efficiency.

8.2.1 PGP: Pretty Good Privacy:

PGP is the first protocol which was developed to provide E-mail security, and is the most commonly used standard program for secure e-mail and file encryption. It is a public key system which uses the RSA public key cipher as follows. First, it encrypts the message using a secret key. Then, it encrypts the key using the recipients public key. When the recipient receives the message, PGP uses the recipient's private key to decrypt the secret key and then uses that decrypted key to decipher the message.

PGP can be also used to sign messages, which helps authenticating and verifying their integrity. It does so by first computing a "hash" of the message using a hash function such as MD5 or SHA. It then, encrypts the hash output(128 bits or 16 bytes) with the sender's secret key. In order to validate the message's

origin, the recipient at the other end uses the sender's public key to decrypt the signature, and calculates the same hash output of the received message. If the output to this decryption agrees with the recipients calculated hash output, then the recipient is knows that: the sender actually sent that message, and that the message has not been changed.

In addition to satisfying the different security objectives, PGP also helps users to manage their keys, by allowing them to create their own private and public keys. Like any other public key users, PGP users also face the users' trust issue discussed under public-key cryptography(section 8.2.1.3.2). One reliable resource for PGP public key users is the FOUR 11 site, which includes a comprehensive list of the public keys it certified.

Even though a new version to support MIME has been recently developed, the new protocol, PGP/MIME, has many complex problems of efficiency, simplicity, and backward compatibility.

8.2.2 PEM: Privacy enhanced Mail:

PEM (Privacy Enhanced Mail) is another system for encrypting mail and making digital signatures. It has been made a standard, but is not as widely used as PGP. PEM has several implementations available such as: rpem and ripem.

Like PGP, PEM catches the main essential security services: encryption, authentication, integrity and certificate-based key management but it does not provide authentication of the recipient. Being a practical standard, PEM can be used with almost every existing e-mail system and someone else who is using PEM.

In PGP, the signature of a message cannot be verified while the message is encrypted. This means that third-parties cannot verify the originator of a message. PEM users cannot send unsigned messages at all , but this is possible with MOSS, the new version of PEM, which will be described in the following paragraph.

Protocol developers and experts think that eventually, the two should merge, depending on which one is first implemented within MIME, and integrated to popular e-mail applications.

8.2.3 MOSS: MIME Object Security Services:

MOSS is a specification that integrates the security services of PEM with MIME. MOSS replaces PEM, and has many advantages:

- It does not require certificates;
- It allows e-mail addresses and arbitrary strings for identifying the public keys of users, instead of only distinguished names;
- And it allows non-text messages including images, voice, video, and structured combinations of contents.

Unfortunately, MOSS is not interoperable with PGP, and it does not provide symmetric encryption services.

8.2.4 S/MIME: Secure/Multipurpose Internet Mail Extensions

S/MIME is another e-mail security protocol which adds security to e-mail messages in MIME format. S/MIME provides authentication (using digital signatures) and privacy (using a symmetric cipher, and a public-key algorithm). The most important feature of S/MIME is its interoperability, which assures that any two packages that implement S/MIME can communicate securely. S/MIME is not a standard yet, but is in the process of standardization. Compared to the three previously described protocols (PGP, PEM and MOSS), is more flexible, more scaleable and provides a better interoperability, which explains its widening acceptance among Internet users.

8.4. Voice security:

Voice is becoming a more common application over the Internet. Within a telelearning environment, when a real time lecture or discussion held using a text based interactive tool such as MOO, MUD or IRC is supported with voice can significantly enhance communication effectiveness. In many cases, though vocal conversations needs to be encrypted, such as in the case of oral tests , or private group discussions. In order to fulfill the need of privacy, several voice security applications have been developed, which use different cryptographic protocols and compression techniques. Some of these tools include: Speak Freely for Windows and Netfone its counterpart for UNIX (Sun, SGI). Both permit encrypted conversations over Internet or modem connections. Another commonly used security applications is PGPFone (Pretty Good Privacy Phone), which, as its name indicates, uses the PGP protocol. Currently, PGPFone beta versions are only distributed in the US and Canada.

8.5 MBONE security:

Like any other technology operating over the Internet, security over the MBONE is very crucial, both at for the applications and for the networks receiving the multicast packets. In view of its affluent and dynamic environment which runs multiple real time applications, and because of the open architecture of

the Internet, the MBONE, at its current state, is very vulnerable to external attacks and intruders attempting to spy on and listen to the multicasted sessions.

For an Internet-based telelearning setting using the MBONE, security is considered as a very central requirement which should be vouched for, especially when holding professional training classes and private lectures, where access should be limited to the registered students. Other cases where security has to be warranted is during on-line presentations, where the transmitted material has to be delivered without any alterations, such as the case of medical images being exchanged between multiple sites.

8.5.1 Applications security:

Most MBONE applications today, such as SDR, WB and VAT, embody some security features such as encryption.

A case in point is SDR, the session directory tool of the MBONE, which permits for private announcements and advertising of sessions and provides the option of holding both, private and public sessions.

Secret sessions, though, should use the same announcement mechanism as public sessions, in order to ensure that their bandwidth is taken into account, and that their multicast addresses are not inadvertently re-used. To do so, SDR advertises the secure sessions twice: once unencrypted with little information about its bandwidth, contact information and multicast addresses, and once encrypted with all of the information including encryption keys for the media tools.

To create a private session, SDR must be pre-configured with a set of private group names and their encryption keys. For increased security, these keys could be exchanged using encryption mechanisms such as PEM (Privacy Enhanced Mail), or through a fax or a telephone. The encryption keys for these groups are not displayed on the interface at any time, and they are themselves stored encrypted in a file. When a private session is selected, a user can only take part in that session if he/she enters a password to SDR to allow to decrypt the key file of the group.

As the MBONE technology becomes more mature, security techniques will gradually become more sophisticated and efficient, promising a safe and secure real time multimedia environment.

8.5.2 Network security:

Security over networks using the MBONE is as a fundamental requirements for securing the networks from risks, such as receiving malicious packets hiding Trojan horse or any other type of virus, which can be very damaging for the entire network.

The most common way used to protect the traditional networks is using firewalls. In a like manner, networks running with the MBONE technology also users firewalls to secure its operations. As described earlier under section 1.2 Security at the IP layer, the Internet routers are configured to filter out any unwanted traffic or harmful packets, and hence called, filters and form a firewall between the local network and the rest of the global Internet. The distinct feature of MBONE filters is that they are configured to allow only IP multicast packets and IGMP message query and update packets to flow into and out of the network. As was mentioned in chapter 2, section 2.3.2.4.3 MBONE protocols: MBONE protocols, it is only those hosts who expressed interest in joining the session by sending IGMP query messages, and subscribed to the group multicast address, who can send and receive data . It is the filters duty, therefore to inspect the incoming UDP data stream, for unwanted UDP packets or non-UDP protocols.

Chapter 9:

POLICY ISSUES

9.1 Introduction:

At the moment, the Internet-based telelearning paradigm is still at its early stages, before establishing itself as one of the common and well recognized academic settings. For this reason, several policy issues which are still encumbering certain learning and teaching activities, and might be representing major impediments to telelearners, should be solved soon.

In this chapter, we will investigate four principal policy issues, which are of big importance to telelearners and instructors via the Internet. These are: copyright, accreditation of on-line degrees, on-line academic fraud and evaluation of Web sites' content and author.

Although a comprehensive discussion of these issues, especially copyright is beyond the scope of this paper, we will be highlighting some of the problem areas, and we will provide an overall idea about each issue.

9.2 Copyright issue:

The Internet' s wide-open nature and universality, combined with the multiplying powerful technologies which allow the easy digitization of any type of information, are creating several copyright problems for both copyright holders as well as the Internet users.

New technologies allowing for easy digitization of different types of intellectual material such as text, graphics, audio and video, software, and photographs, bring in new chances for some "bad" Internet users to use copyrighted material illegally, such as making free unlicensed copies, modifying them, and distributing them.

Within an Internet-based telelearning environment, easy on-line accessibility to intellectual information, whether copyrighted or not, is fundamental for an effective and affluent on-line dissemination of educational material. The unsolved copyright issues of on-line intellectual material, can in many cases impede on-line students and instructors from benefiting from the Web's resources to their full potential. In many other cases, telelearning practitioners might even find themselves involved in unlawful acts of copyright infringements without even knowing or intending it.

Some stakeholders like the Canadian Copyright institute and the Society of Composers, Authors and Music Publishers of Canada (SOCAN), believe that even browsing on the Internet constitutes a reproduction and can result in copyright infringement. According to their argument, the idea of Stentor, the alliance of Canada's major telephone companies, about the possibility of drawing a distinction between downloading and accessing a document is not possible. In order to browse a document, it must be first accessed and then downloaded. Once displayed on the screen, the document can be easily copied to the hard drive, which is a reproduction.

Furthermore, the international aspect of the Internet makes it easy for any Internet user with a powerful PC to illegally reproduce copyrighted documents, without risking, in most of the cases, being tracked or legally sued.

One other problem that aggravates the copyright issue for copyright holders is the strongly established Internet culture and belief that Internet material is free, and that it should be widely disseminated, as expressed by user groups. Changing this widespread netiquette is very difficult, and will need a great effort and a lot of time.

When it comes to using the Internet material for telelearning, users can be easily entrapped into copyright infringement, unintentionally, in most of the cases. This is mainly because of the unclear rules and the lack of user education about when and what acts constitute a copyright infringement.

Based on a DEOS-L mailing list discussion about how to overcome the copyright of electronic material handicaps, several members accorded the suggestion that on-line instructors should be looking primarily, to the different government sites, since they cannot be copyrighted. However, in many cases, the subject related data and information is inadequate, or is non-existent in such sites.

In case copyrighted on-line material is required, participants believed that it is always better to have the copyright owners permission than not to ask and be in trouble later on. Based on the experience of some of the discussion participants, many owners of copyrighted digital material, mainly other educational institutions, government agencies and several corporations, were very cooperative and willing to allow them to use their Web sites for educational purposes. As long as long as they don't print the page out and make "thousands of copies", the copyright owners do not object accessing their material.

The following are some cases of illegitimate acts, which can take place while operating within a telelearning environment.

One of the very common situations is when students need to “write” a multimedia document present it in class. In order to supplement their work with the necessary material, students might need to integrate several forms of multimedia files, such as photographs, audio and video clips, which are in most of the cases, other people’s creation and are copyrighted. Using them without permission is a clear violation of the owner’s copyright rights.

Another case where many telelearning practitioners are unlikely to consider it to be a violation, is when instructors use some Web sites to complement their lectures, by copying the sites contents over Powerpoint slides. As one member of the DEOS-L mailing list puts it “caching (the Web page content) into a Powerpoint presentation constitutes a copy, and therefore a copyright infringement”.

The same effect emanates when telelearning practitioners, whether instructors, students or even administration staff, build up Web pages with several links to other people’s copyrighted material on the Web. The WWW is considered to be an electronic form of publication. Therefore, if anyone intends to publish Web pages containing any material from someone else’s Web site, he/she must have the permission of the authors of the original work to avoid liability under copyright law. This applies not only to whole works, but also to sections of works, such as passages of texts, pictures, etc.

The main point worth noting about the previous examples, is that the used Web pages included material which is not only created by the Web page owner, but also by others. The copyrights of the embodied links in many cases have not been obtained. Therefore, using that material for presentations or for integration in other works can be a copyright infringement which goes beyond the page creator, and involves others who have a vested interest in using the page material.

Other cases of infringements that are likely to occur unwittingly within a telelearning environment, is posting other people’s material on the net without the person’s permission. A case in point, is when instructors post any type of material (articles, sections from books, photographs, audio and video clips) thinking that this act falls under fair dealing, where using other people’s work for educational and research purposes doesn’t constitute a copyright infringement.

In view of this awkwardness and impediments to a problem free telelearning environment, quick solutions to these issues is essential.

One easy and rapid alternative is to contact the original author for permission. This can be either by writing to the Webmaster of the site, or by looking up the person's name in one of the Web electronic directories. However, it is not always easy to reach the Web site's creator. For this reason, a clear policy needs to be outlined in order to make legal reproduction of educational material easier, clear and less complex.

Copyright laws all over the world, as well as international copyright agreements blur when it comes to the Internet. Similar to the governments attempts to solve this issue, the Canadian government, in 1994, has created the Information Highway Advisory Council(IHAC), in attempt to develop a national strategy to allow it to cope with the challenges of the information technology environment. One of the important responsibilities of the council was to review the Canadian copyright law in the context of the new information technologies, such as the Internet, and to come up with recommendations relating to copyrights of on-line multimedia works, browsing and fair dealing. This duty was delegated to a Copyright Subcommittee which involved two main stakeholders:

- Copyright owners: such as agencies representing musicians, authors, newspaper producers, radio and television directors, and photographer, who were concerned about legal protection of their properties.
- User groups: which comprised educational institutions, researchers, libraries, and Internet users, who believe that since the Internet is presumed to provide universal access to intellectual material, there should be no barriers to reach on-line material and that the government should limit the copyright protection.

The Copyright Subcommittee's report later, served as a basis for the council's final report and included several recommendations. The following paragraphs highlight the principal prepositions of the IHAC which relate to the digital intellectual properties copyright.

9.2.1 Principles:

The government should set clear principles to help addressing the digital material copyrights issue, which would help the learning community, which is a major user of these works, in understanding the amended legislation. These principles should be principally based on:

- Balancing the creators rights and the requirements of the users (including the education and learning environment) to have an easy access to those works.

- Providing the users community with the necessary help to understand the need for the legislation, and developing programs to explain how the law should be implemented. Users should understand that copyright protection is crucial to ensuring that creators, producers and distributors receive rewarded for their effort and investment. Such compensation will encourage copyright owners, to give more contributions to the learning and educational environment.

9.2.2 Multimedia works:

Even though some stakeholders suggested a more specific definition of digital multimedia works, the council believed that the category Compilation adequately defines multimedia works. Further, they were convinced that digital works do not represent a new category of works, but it's rather a different way of presenting works. Therefore no amendments should be made under this section.

Including a technology specific definition of digital work, like what some stakeholders, such as the Canadian Association of Photographers, suggested, would require frequent amendments to the law. The fast technological developments and the time required to introduce statutory regulations will result in outdated definitions.

9.2.3 Browsing:

As discussed earlier, browsing copyrighted digitized material is a confusing element. In its final report the council recommended that the Copyright Act should be amended to clarify what constitutes browsing and infringements by browsing, and what works are "publicly available" include a definition of browse. The Council agreed with the copyright subcommittee in that "the act of browsing a work in a digital environment (which includes the Internet), should be considered an act of reproduction". Their suggested definition was: "Browse means a temporary materialization of a work on a video screen, television monitor or similar device, or the performance of the portion of such work on a speaker or similar device by a user, but does not include the making of a permanent reproduction of the work in a material form."

Council members representing copyright holders considered that browsing, could mean either accessing the work, or making a copy. User groups on the other hand, felt that this would limit access to these works, since even simple access with purpose of determining whether the file would be needed or not, can result in an infringement. The final recommendation was that creator should be able to identify when and what parts of their works can be browsed and be publicly available.

9.2.4 Fair dealing:

During the Copyright Subcommittee discussions, user groups, principally educational institutions, were arguing that since it is very important for the Internet material to be widely disseminated to promote universal education, free access to on-line information and its availability for the open public should fall under section 27(2) of the copyright act . It states: "The following acts do not constitute an infringement of copyright: any fair dealing with any work for the purposes of private study, research, criticism, review or newspaper summary".

In its final report, the council was of the opinion that the fair dealing provisions don't need to be amended, and that they apply to the digital material. These provisions however, should be made more clear and more specific, to help user groups understand the scope of the fair dealing exceptions and the nature of copyright liability.

9.2.5 Moral rights:

Under the Copyright act, moral rights are defined to protect both the integrity of the work and the author's reputation. According to section 14.1 of the Copyright act, infringement takes place when the work is "distorted, mutilated, or otherwise modified" or "used in association with a product, service, cause or institution" resulting in biasing the author's reputation. Infringement of these rights is very easy over the Internet using the free available software which can filter messages and modify document contents, by changing colors, removing parts etc.

User groups were convinced that certain information, such as government statistics, regulations and laws should be made widely available. It is in the public's interest therefore and very important to protect the integrity of this type of data by preventing users from modifying them. The council recommended that the government should make government information available without requiring any payments or authorization, very helpful requirement for the learning community. Further, the council advised that "the legal framework governing copyrights should ensure, rather than curtail the development of systems to monitor the uses of copyrights..(of on-line digital material)".

9.2.6 Administration:

In order to ensure an effective administration of the copyright law, the council recommended a combination of technological, policy and legislative solutions to be used.

Some of the technological solutions include:

- **Encryption:** as discussed under chapter 8: “Security issues”, encryption is one of the effective solutions to ensure security. Applying this technology to a multipoint system, however, becomes more complex and could involve high administrative costs.
- **Electronic fingerprinting:** this technology involves taking a virtual electronic fingerprinting of the CPU or the system, and uses it as a key to encrypt personal secret keys, IDs and passwords onto the user’s hard drive. The system’s token is never stored in clear text anywhere, and if illegally moved from the original computer system, it will not operate and becomes useless, as each system has its own unique electronic fingerprint. In order to move the application, the fingerprint must be uninstalled then moved. This keeps applications from illegally multiplying at a customer’s site.
- **Tagging:** is a method used for inserting a copyright notice or other message into the protected work to inform users that no illegal copies should be made. Tags can be the name and registration number inserted into a software program, or a logo of an organization. For copyright, the Copyright Subcommittee suggested inserting a copyright notice scattered throughout the content.
- **Conversion/Anti-Copying:** This technology involves transforming the digital work into an intermediary form so that the original information cannot be edited or altered. By applying this method, unauthorized reproduction is impeded since the quality of the work diminishes with each successive copy.
- **Copy prohibition:** copy prohibition can be realized by including bits in the digital content which preclude copying on certain electronic machines. When the file is downloaded or is being read by the machine, the saving (or recording) function is disabled.
- **Digital coding:** One of the examples that the Copyright Subcommittee included to illustrate the efficiency of this method in securing digitized materials, is the digital coding technique developed by CyberTech Systems Inc. The main characteristics of that code is that it is inaudible, unremovable, automatically copied and can be used on anything that utilizes a soundtrack. By replicating only a portion of the digital numbers and randomly scattering the remaining invisible numbers in the audio tracks, no modification of the soundtrack is possible without removing a part of the soundtrack. Moreover, the manipulation of the code creates “residue codes” to prevent tampering. As a result, any attempts of tampering the audio track are hampered.

With respect to policy measures, the council was convinced that the government should support and assist the industry in the development and use of the technological solutions. This can be, for instance, by standardizing the technologies and educating users and creators about their use. Further, the IHAC advised that “the government should take an active role, in partnership with industry and the creator and user

communities, in a public education campaign to better inform users and creators about the use of the copyright.”

Regarding, legislative actions, it was suggested to include a section under the amended copyright act, stating that any manipulation or attempts to break the copyguards or encryption technologies with the purpose of transgressing the work’s copyright is considered a criminal offense.

9.2.7 Public education:

Informing users and owners of copyrighted digitized intellectual material about the rights and responsibilities of each party is very critical to ensure that the act is effectively and flawlessly implemented. The council concluded that public education is a shared responsibility between the government and the user and creators group. In their opinion, users as well as creators, have the duty to educate themselves about the digital material copyright.

When it comes to Internet users, including the telelearning community, the Copyright Subcommittee believed that changing the wide perception, or netiquette, that the Internet is a free zone for the open and unrestricted exchange of information, whether it is proprietary or not, should be changed through an extensive education campaign. First, the program should use extensive advertising, which can create a new impression that infringing digital materials copyright is a criminal offense. Next, academic institutions should be involved to ensure that their students and faculty have a clear understanding of the copyright principles. With more on-line educational institutions using the Internet resources as their principal source of information, an important section in the course curriculum should be included to teach students about their duties and rights when using copyright digital material and what constitutes an infringement.

The council members further, suggested that the government takes an active role, during these campaigns, by leading as an example in implementing the new regulations, and participating in enforcement programs.

Following these recommendations, Industry Canada has started working on the different sections of the proposal by designating focus groups in early September 1996 to discuss the different Internet liability issues, chiefly the issue of who should be liable over the Internet.

The open anarchy and the international aspect of the Internet means that Copyright law amendments should not be restricted to the national level. Given the importance of the Internet, the threat of copyright infringement is an issue affecting all countries. Even if instructors or students, or any other Internet users are deprived from downloading a national copyright holder’s material (textbooks, photographs, audio and

video), they can still violate the rights of a foreign copyright holder, without the risk of being tracked or punished.

Even though, today, there is no common international copyright law, international copyright agreements exist, like the Berne Convention and the Universal Copyright Convention, which are the primary sources of international copyright law. These conventions might provide some basic help, but they still need to be expanded upon. By harmonizing the different legislation and improving the international treaties, mainly by adding clear and specific definitions of what constitutes a violation of an Internet copyrighted document, unauthorized material could be better protected.

9.3 Accreditation:

Judging the quality of the delivered academic programs and degrees is a very important issue for many stakeholders including: telelearners and their families, academic institutions, sponsoring bodies, governments, and employers, especially when the program is offered at an international level. Already hundreds of courses and degrees are being offered on-line today, and competition is starting to intensify.

The low costs involved in developing and publishing an on-line course and creating virtual educational institutions, along with the students' need for more flexible educational services, have significantly encouraged this shift in the educational environment. One of the main implications of this change is that telelearners are very likely to have difficulties on deciding about the program to follow and the courses to choose, while ensuring that they made the right choice.

One other issue is that educational standards and evaluation criteria of degrees and programs can vary widely from one country to another, and sometimes even within the same country. Moreover, dealing with students scattered all over the world, who will later use their on-line degrees in diversified and dissimilar job markets, represents big challenge for virtual educational institutions, since the degree has to satisfy the telelearners local job market requirements.

When selecting an on-line course or program, students need to be sure that their learning experience and the earned degree is equal in value, or even better than if the same course was taken with a conventional institution. Furthermore, they have to be convinced that their degree will be accepted by other existing educational systems, and that credits transfer to or from other programs (on-line or traditional) is feasible.

These requirements are of big importance for telelearners, especially those who strive to build their career using the received degree, in contrast to other on-line students who might be taking courses just to improve their aptitudes or to increase their knowledge in some areas.

One of the fundamental objectives of on-line institutions is to guarantee the universal access of public to educational resources and high quality learning material. Lacking the means to assure the telelearning community about the quality of their programs, can limit the on-line institution's target market to local levels and lower their enrollment rate, which contradicts their primary objective of universal reach.

Another side effect of the lack of accreditation standards is that students can be discouraged and confused when evaluating whether the program is really worth its costs or not. To cite an instance, basing one's choice on criteria such as tuition fees can be, in many cases, misleading. Even though some subscription fees are high, they might not reflect a high quality program. Also wrong assumptions about the appropriate time needed to finish the course might incorrectly reflect the effectiveness of the program and can result in costly wrong decisions.

Issues like these and others, urge the need for the development of an accreditation body for assessing and evaluating on-line programs. Accreditation is a rigorous evaluation process that is guided by a defined set of evaluation criteria established by the accreditation body. This includes numerous stages of team evaluation and on-site peer review and evaluation visits. Accreditation plays an important role in every student's professional life. Graduates from non-accredited institutions would have less job and advancement opportunities than their peers from accredited institutions or programs. For the job market, accreditation offers industry a certain minimum guarantee of the skills they can expect in job applicants, and therefore it promotes high quality work environments. As quoted in a California School of Independent Schools accreditation article, "....accreditation is a means for fostering excellence in education and encouraging improvement through self-study and evaluation." It also enables the institution to develop a clear set of goals and objectives and promotes continuous controls and reviews for its strategies to ensure that all objectives are satisfied.

Similar to the accreditation process followed when evaluating traditional courses and degrees, national accreditation organizations should be involved in applying standards for assessing on-line programs. Today, a number of professional associations, such as the Canadian Information Processing Society(CIPS), have established accreditation councils for specific programs and courses offered in conventional

universities. Extending these organizations activities to on-line programs would promote on-line accreditation processes. One point worth noting, though is that these councils would have to amend or add new criteria to its accreditation parameters used for conventional programs. Two of the new measures which should be focused on are:

- Evaluating if the new telelearning setting affects the telelearners learning and the efficiency of the programs activities.
- Assessing the support level provided on-line by the faculty with regards to all the students needs.

Since the most powerful aspect of virtual institutions is their international reach, recognition of these programs across the international borders is an exigency across. At this time, there are two global accrediting agencies: "The International Accreditation Commission for Post Secondary Educational Institutions", and the "World Association of Universities and Colleges". Accreditation by these agencies is based on a thorough evaluation of the academic programs of the institution, the institution's instructional resources, its financial stability and its professional integrity.

These already existing bodies can extend their activities to involve the on-line programs, which promotes establishing confidence in the offered on-line programs, and helps validating the integrity and the quality of the on-line Internet-based programs. One evaluation element however, which might be considered less important for virtual institutions than for the conventional ones is the value and the availability of the instructional resources. Since all institutions will be using the same source of instructional material: the Internet, therefore all telelearners will be using ubiquitous resources of equal value to everybody.

Further, reciprocal accreditation recognition could be established between other already existing national accreditation agencies which accredit programs within single disciplines in order to promote the international acceptance of on-line degrees. These procedures are likely to be uncomplicated and smooth especially for disciplines with a universal aspect like the scientific and engineering field. A case in point, is "The Accreditation Board for Engineering and Technology (ABET), Inc." which has begun development of reciprocal accreditation recognition on mutual recognition of evaluation programs implemented in Australia, Canada, Ireland, New Zealand, United Kingdom, Hong Kong, and the United States. As a result professionals from any of these countries could practice without any restriction from other country members.

Like the conventional programs' accreditation procedures, accreditation of on-line programs can involve the same procedures, which include:

- First, using the set of criteria of the national accreditation body or the International council, the on-line institution faculty conduct a self assessment of the quality of their program.
- Next, members from already accredited on-line institutions, selected by the national accreditation body or the International committee, evaluate the program by examining its different elements and interviewing students and staff members, then write an evaluation report to be submitted to the international committee.
- Finally, based on its set of criteria about several elements, which focus mainly on issues related to program quality, integrity and student support, a committee from the international accrediting council (which also constitutes a number of faculty staff and experienced educators in Internet-based telelearning) reviews the assessment report and recommendations, then makes a judgment and publishes it on-line for the general public.

By publicly announcing the decision, the committee proves the accountability of the institution and assures the telelearning community about the program's quality.

One point worth noting, is that analogous to traditional programs, it can be anticipated that many high quality on-line institutions might balk at the accreditation process and refuse to consider submitting to it, if it is like the present accreditation processes, expensive, lengthy, and complex. Therefore, universities today often follow program guidelines from a professional agency, such as the Data Processing Management Association(DPMA), and the Association for Computer Machinery(ACM), without that organization actually evaluating whether the guidelines are being followed.

Further, some requirements to earn accreditation might be difficult to satisfy. For instance, to be accredited a program needs students. However, since many students might not enroll in non accredited programs, the enrollment rate would be always low, depriving the institution from the various advantages which come with accreditation, such as the potential opportunities of increasing its enrollment rate and being among those seeking front positions in the Internet-based telelearning setting.

The idea of instituting an international accreditation body might be in the short run, difficult and very time consuming to realize and to reach a compromise between the different accreditation criteria of worldwide

national accreditation bodies. Its outcomes, however, are very significant for the telelearning community and in the long run it will play a major role in improving on-line education via the Internet.

One interesting point to note, is that it is likely that many on-line institutions and programs will be hybrids of contributions of multinational educators and staff. The main advantage of this diversity is that their contributions can help in setting a program which will most likely satisfy many evaluation criteria elements of student with different cultures and backgrounds.

9.4 Academic fraud:

With the proliferation of on-line programs and virtual institutions, issues related to examination and evaluation, such as academic fraud and student credibility, are of major concern to many telelearning practitioners. Testing students is essential to determine how well students are meeting course objectives. They help to verify if the student assimilated the course material and help in revealing any misunderstood, misapplied or poorly mastered material. These issues were a hot topic on the Distance Education On-line Symposium (DEOS-L) mailing list, during the month of January 1997.

Many on-line instructors believed that chances of academic fraud in on-line environments are higher than in traditional classes. When an on-line Internet medium is used for testing, such as text based conferencing tools, or WWW conferencing , preventing cheating is difficult since there is no way to force students to close books or to prevent them from getting help from somebody seated besides them. On the other hand, many other participants were convinced that academic fraud and plagiarism are not any riskier than in face-to-face classes. These concerns have been around for a long time, especially those of defining the student's identity, regardless of the class setting. One participant asked these questions in an attempt to justify this point:

- How can (on-line) instructors know that the student who took the on-line final exam is the same who took the course?
- How can they be assured that the student who hands in a paper in an on-campus, face-to-face course, or on-line is the same student who researched and wrote the paper?

Both questions can be applied to any type of educational setting, whether on-line or face to face. Based on the participants' experiences, the incidences of fraud seemed to be low in face-to-face classes, and they are

expecting that the same pattern would apply for on-line courses. It is true that by not having any imposed supervision some students might behave dishonestly. Some of the measures which can be applied in order to limit the risks of academic fraud is to apply a hybrid of technological and pedagogic solutions.

With regards to technology, several tools described in Chapter 7: “Security over the Internet” can help in limiting the risk of fraud. Such tools include: public and private encryption keys, passwords, system authentication and digital signatures;

Concerning the pedagogic methods, an instructor can apply the following measures:

- Including more group projects, case presentations and term papers in the curriculum. An instructor can either assign a heavier weight to these activities or use them as the only methods for evaluating students. This method is becoming more popular even in traditional face to face courses, and is proving to be an efficient method to help students assimilate better the course material by researching subjects deeply.
- Holding on-line text based or oral discussions, and basing evaluations on students’ contributions during the discussions. The same media can be also used for on-line oral tests, where student are required to answer within a limited time.
- Setting exams in test centers under the supervision of assigned proctors, where the identity of students can be verified. This option might be very costly for the virtual institution, especially when students are widely scattered within the same country or around the world.
- CyberHigh, an entirely on-line high school, tries to limit plagiarism and fraud by emphasizing in its academic policy that doing work for students is an immoral act, an that such acts deprive students from learning. As in-school teachers recognize their students’ work, CyberHigh teachers use continuous interaction and work with the students as a means of helping them recognize their students work.
- Once high-speed Internet access, and broad bandwidth over the Internet become widely available to the telelearning community, live audio and video presentations can provide big assistance in assessing the students’ performance. For instance, students presentations can significantly be enhanced as they will be integrating more multimedia files which can be of big assistance in conveying their ideas.

Despite the different solutions and measures used to restrict academic fraud, students operating within any milieu, be it on-line or not, and who are determined to act dishonestly, are likely to find ways to do so. As one DEOS-L participant put it: “(instructors) keep raising the bar, and such students simply jump higher (or go under)”. Many others were of the view that since instructors trust their students when they see them,

they should now learn to trust them “just a little more” when they don't. Moreover, since students trust their on-line instructors, likewise on-line instructors should trust their on-line students.

Applying a hybrid of the above suggested solutions can certainly “raise a “reasonable bar” for the high-jumpers”, but this issue always remains to some extent the student's personal and moral responsibility more than an enforced discipline by the institution's authorities.

9.5 Evaluation of the Web site's content and creator:

Before any information over the Web is used, users, especially students researching material on their own, must be able to evaluate the site's content and its author's credentials in order to be assured about the accuracy, credibility and validity of the obtained information.

The low barriers for publishing over the Internet, and the prevailing netiquette of free-speech over the Net, requires Web users to be extremely critical consumers of information which comes through the World Wide Web. With the open nature of the Web which allows many unknown information providers, be it individuals, organizations, or associations, users, especially young telelearners should be trained on adopting critical attitudes towards any material encountered on-line.

Before the Web, printed information resources, such as books, magazines, newspapers and even personal correspondence have been designed and written following a clear set of conventional guidelines, and structured formats, which agree with the expectations of the readers. A case in point, is that when reading a book, readers expect to find a biography about the author's background, previous works as well as the educational level. In a newspaper article, a journalist is expected to present accurate information free of advertising.

With the emergence of the Web, traditional specifications no longer accord with Web documents. Web users today, have to modify their criteria when judging the worth of on-line Web sites content. Most Web files come in non- linear communication formats, with little or no information about their creators, their accountability, their motives and objectives behind building these sites.

Despite the dilemma a user can be trapped in while researching topics, setting a clear set of parameters against which the site's value can be assessed is essential for Web users, primarily telelearning environment

members, to get the maximum benefits out of the invaluable Web resources. These criteria should emphasize elements such as: the authentication of the site's author, evaluation of credentials, assessing newness of the material, and evaluating the design and layout of the site.

The following section will describe some of the general guidelines for users, regardless of whether these are students or instructors, which could help them in evaluating Web sites contents and their authorship.

9.5.1 Authenticate the Web site creator(s):

Determining who created the Web site, and from where the information originated is the foremost component to consider when evaluating a Web site's content. Even though many sites may not include direct information about the creator(s), many others either provide information in the title or somewhere in the front page, or in the form of hypertext links called "About" or "information", or logos and question marks, which once chosen provide users with more detailed information about the developer(s) of the site.

Unlike printed materials and books which often include an editorial review or biography about writers, it is very rare that electronic files contain that type of information. In many cases information about individuals is limited to an e-mail address, or to a link to the author's résumé. When the developer is an organization, very often a brief introduction or description about its mission and objectives is available.

In case no link to any already existing on-line information about the author(s) is available, the e-mail address can help determining whether the author is an individual or a group, and the type of institution he/she or they are associated with. To illustrate, e-mail addresses with user name "Webmaster" or "Info", often mean that a group of people are responsible of the site. For instance, education@info.apple.com, means that information about the institution can be provided by the person or group of people who are looking after that site.

When the user name in the e-mail address represents an individual, the domain name can provide an idea about the type of organization the creator is associated with, and in many other cases, the country from where the site is originating can be known. As a model, joe@abc.uottawa.ca implies that the individual is likely from the University of Ottawa, which is in Canada. An e-mail address which looks like joe@aol.com or joe@prodigy.com, on the other hand, suggests that the individual is asking people to e-mail him at a private e-mail address.

Another method which helps to find about the creator(s)'s background and the file's origin is by looking at the site's URL. Similar to e-mail addresses, the top level domain name in a URL, provides information about the creator(s)' organization, as well as the country of origin.

The following table lists some of the common domain names of the Internet and their meanings.

Table 9.1 List of common domain names of the Internet

Domain name	Description
.com	For-profit commercial organization
.edu	University or research institution
.gov	government organization
.org	not-for-profit organization
.net	Internet service provider or facility.
.mil	military organization
country codes. such as:	for countries other than US,
.ca	Canada
.jp	Japan
.tn	Tunisia

The URL also provides information about whether the publication is maintained by a department in the organization, or by an individual who might have used the organization's system to post his Web page.

Usually, when a URL belongs to an individual, a tilde (~) appears in the site address followed by the creator's name. For example <http://www.admin.uottawa.ca/students/~joe>, means that web page belongs to a student called Joe from the faculty of administration at the University of Ottawa, which is in Canada. Some URLs however might not be as clear as this URL. By way of illustration, the following address doesn't tell much about the user: <http://www.kn.dgbl/~s664965>, nonetheless, it still tells that the page belongs to an individual because of the tilde.

Exceptions to the tilde rule apply when the author is publishing the Web page via a service provider such as the following URL: <http://home.aol.com/joe>. This URL indicates that it is an individual's home page because of the service provider's name.

URLs without tildes or service provider name, are most likely published by a branch in the organization, such as <http://www.admin.uottawa.ca/mba.htm>, which indicates that the site is a top level Web page of the MBA program at the University of Ottawa in Canada.

Even though it is recommended that Internet users, especially students making individual research stick to sites of well known organizations and entities, such as universities, research institutes, like NASA, and

information sources like well known newspapers and magazines, many individual publications and Web pages in many instances can also represent invaluable sources of information.

The point is that many Web users are convinced that sites maintained by groups usually, mean that information is well maintained and frequently updated. Moreover, having a group of people looking after the site means that more than one individual are interested in the site and that this can imply a longer existence and a higher chance of stability of that Web page than other individual sites.

In order to make their pages more acceptable and attractive, individual page authors should be more concerned about the design and layout of the page. Most importantly, they need to provide users with a certain level of security and assurance that the available information is valid, accurate, and reliable.

9.5.2 Evaluating credentials:

Whether the site is developed by a group of people or an individual, it is important to evaluate the author(s)' credentials and qualifications, in order to warrant the validity and credibility of the received information. The open Internet environment and the low barriers of entry pull in opportunities to those individuals or groups and associations which intend to propagate wrong and/or dubious information, especially those relating to controversial issues.

One method which can assess the accountability and reliability of the material is by looking at the author's job title, history and their educational level. Likewise, verifying if any qualifications (medical, academic, journalistic, etc.) are indicated, lead the reader to expect the author(s) to hold a certain level of responsibility and accountability for the published material.

Many sites provide valuable and valid information but the lack of qualifications, good design, language skills and information about the author makes the content seem invalid and unreliable. One solution to such cases is to contact the author via e-mail and ask about the sources of the information.

9.5.3 Assessing the recentness and maintenance of the information:

Knowing how often the information is updated, and when it was posted is an important factor when evaluating Web sites' content. Usually, indications at the end of the file such as "This page is updated every.(day, week, or month or quarterly etc.) .." or "This page last updated on..." or "What's new for ..(month or day..)", inform users about the frequency of updates and the recentness of the material. Even in

case similar information is not available, most Web browsers have an option such as “Document Info.” in Netscape, which provides information about the file creation and modification dates.

Frequently maintained sites indicate that the Web page is very likely to be stable. It is very common with the Internet that sites come and disappear without notice. For research and educational purposes, it is preferable that users have a certain level of assurance that the site is stable, especially when an instructor is willing to use some bookmarked sites as reference to support the lecture, or when students use them for reference in research papers.

9.5.4 Layout and design:

Well designed and organized sites can significantly help users in assimilating the site's content, and enable them to easily navigate the different links. Design and layout considerations are very important points for a telelearning environment, since Web resources would be a fundamental tool for instructors to support their lectures. The lack of face-to-face contact and may be also real time interaction between instructors and their students, require the use of clearly laid out sites. This would guarantee that the educational message is conveyed, and that users will not loose interest when navigating the site.

The main characteristics of a well designed Web site comprise the following:

- Appropriate use of headings and titles which inform users about the page contents and indicate where they are in the document.
- Fixed navigational elements present in every page of the document to help users return or go to any level of the document at any instant. By way of illustration, including arrow buttons and links to the different sections of the document, including the home site, significantly help to easily navigate the document.
- Ability of understanding the document in text version, without the need of images and graphics. This requirement is of major importance for telelearners with slow Internet connections, who can be frustrated when downloading sites loaded with large graphics, multimedia and photographs.
- Appropriate use of hypertext links. Most importantly, the links must be working and valid.
- Graphics should be informative and not very flashy to a degree which distracts the reader's attention. Graphic should principally aid users in understanding the information or providing options of navigating additional material which could support the information.
- Providing additional links to other relevant information also indicates a well designed site and implies that the site's author(s) wants to help users in assimilating the site's material.

The following table provides a checklist of elements to be considered when evaluating a web site.

Table 9.2 Checklist of elements of evaluation of Web material

Authenticating the Web site creator(s)
<ul style="list-style-type: none"> ➔ Is the developer of the site identified? ➔ Are there any information or links to biographic data about the author(s)? ➔ If the developer is an organization or association are there any information about its mission and objectives? ➔ are there any contact information?
Evaluating the web site's content:
<ul style="list-style-type: none"> ➔ Are there any credentials and qualifications? ➔ How valid and reliable are the credentials? ➔ How comprehensive is the content,? ➔ Are there ant further references and links to additional material and a bibliography which Can support readers in understanding the material? ➔ Is it possible to distinguish between the author's views and facts?
Web site design and layout
<ul style="list-style-type: none"> ➔ Is the site well laid put and organized? ➔ Are there any fixed links to help navigating the document? ➔ Are hypertext links functional? ➔ Does a text version of the document still allow users to understand the content? ➔ Are graphics properly used? ➔ Are graphics distracting users' attention?

CONCLUSION:

Before proceeding into establishing an Internet based program, a certain number of issues should be taken into consideration by telelearning practitioners, including instructors, administrative staff and students, who should be well prepared to cope with such obstacles.

When it comes to an issue such as security, a virtual institution's strategy should be outlined in such a way that it preserves a certain degree of privacy and security to the institution's operations, especially for sensitive student related matters such as on-line payments, transcripts and on-line tests and exams.

With regard to policy issues, such as copyright, academic fraud and evaluation of the Web's material, both instructors and students should be trained and educated about respecting certain legal and ethical protocols, and to cooperate in creating a competent and reliable telelearning environment. Many other policy issues, however, such as accreditation can only be looked after by higher level parties, and it is the faculty's responsibility later to inform and educate its members about any new decisions and to implement it properly.

CONCLUSION

1. Looming Trends:

Saying that the Internet is bringing about a major paradigm shift and an influential impact on every aspect of our life, including the educational environment is a fact that can't be denied. Being among the very first milieus to be captivated by the Internet's appealing singularities, the educational community has been witnessing the emergence of a new momentous trend towards Internet-based telelearning and training. As illustrated in Part 2: "Current Implementations of Telelearning via the Internet", already hundreds of virtual academic institutions, on-line programs and stand alone courses are being offered via the Internet. Moreover, based on its April 1997 survey, International Data Corp stated that telelearning via the Internet will be the fastest-growing segment of technology-based training in 1997.

The new occurrences in the academic environment resulting from the wide deployment of the Internet, come under two categories: teaching and learning trends and organizational trends.

As for teaching and learning, the Internet has remarkably become an integral part of the educational settings and is being deployed for almost all administrative and learning activities. This applies for the basic Internet tools which involve primarily, e-mail applications and the Web. Sensitive operations, however, such as on-line payments, transcripts and registration, are still mostly done off line, mainly because of the faculties reservations about the security of the medium. All these conclusions are confirmed by the findings of the two surveys discussed in chapters 4 and 5.

Moreover, multimedia synchronous and asynchronous tools, such as multimedia MUDs and MOOs and CUSeeMe, are quickly becoming common tools for on-line lectures, presentations and class discussions, by virtue of their powerful features which support high quality instruction. Also progress in high speed technologies is encouraging a wider deployment of higher bandwidth multimedia applications.

With respect to the organizational trends, the distinguished outgrowth is the emergence of new totally on-line, also called virtual institutions which interact remotely with their students. Students can come anywhere from the world and can either meet anytime asynchronously, or in real time using any of the synchronous Internet tools, such as MUDs, MOOs, IRC, CUSeeMe and even the new promising MBONE technology. Part I of this paper discusses a wide variety of these tools

At the same time, conventional academic institutions have also started offering Internet-based on-line courses, programs, and degrees, which are remarkably flexible and convenient for students with different

life situations. As a result, it is very likely that many institutions would significantly increase their enrollment rates and could better cope with the increasing financial constraints. Several case studies of such new types of virtual and hybrid institutions are included in chapters 3 and 5.

Likewise, new on-line support services for educators, such as those offered by the Global Network Academy, along with the low cost publishing, has encouraged many instructors to offer stand alone courses, which would be of great benefit to those telelearners looking for upgrading their skills in very specific areas.

2. Main motives behind the advent of Internet based telelearning:

Among many other reasons, the following are two of the main considerations of this phenomenon:

1. The Internet technology is robust, simple, multi-platform, and more important, cheap to use. From the point of view of the students, savings are mainly related to: travel expenses, inexpensive higher quality learning material constantly available at their finger tips, and possibly lower tuition fees than conventional academic institutions, on account of the lower involved institution costs and the increased competition. Students and institution related costs are analyzed in Part III.

In respect to the academic institutions, with the escalating training costs, shrinking budgets and reduced governmental funding, Internet-based telelearning represents a very cost effective alternative to face-to-face teaching and learning. Significant savings on facilities and training expenses and extra staff related costs can solve or at least alleviate some of their financial problems.

2. The Internet is highly interactive, flexible and user friendly. The developments of user friendly Internet tools and software technologies, described in Part I, are ceaselessly making the medium highly adaptable, more attractive and more useful than it already is. Progress in the capabilities of already existing tools such as improved support of multimedia, and real time conferencing, are offering new options for a higher quality knowledge transfer.

3. Limiting Impediments:

Despite the powerful and several unique features of the Internet, Internet-based telelearning is still encountering some impediments, which are restricting it of being deployed to its full potential. These include:

1. The resistance and reservation about the quality of Internet based instruction, the educational value of on-line material, which is still prevailing among many faculty members. A method of assessing the educational value of Web material is suggested in chapter 9, section 9.5.
2. The various technical and policy issues which are discouraging many training and educational organizations from deploying the medium for more cost effective and high quality teaching. These issues involve mainly, among many others, security, copyright, online academic fraud, accreditation, etc. A set of these policy issues is covered in chapter 9.
3. Internet access and computer literacy, at the worldwide level is still not common especially in rural areas and developing countries. As a result, many communities are being deprived from the potential benefits of this medium.

4. Future avenues:

In this study, we have discussed and analyzed some of the main aspects of Internet-based telelearning, primarily the technological and economic elements related to this new form of knowledge and education transfer. However, still many other areas have to be investigated, and several questions should be answered, such as:

- How can the Internet tools be improved in order to be more convenient for the various types of instruction? To cite an instance, how can the present simulation software and user interface be augmented in order to be as competent in conveying the learning message and as practical as real life experiments performed in conventional labs or studios?
- How can the Internet medium and technologies be designed and/or amended in order to accommodate almost all levels and all types of learners, such as children and students with special needs?
- How would administrators and faculties design their strategies, in favor of a high quality on-line education which can be accepted by the worldwide learning community to be as competent and as potent as the conventional face-to face education?

APPENDICES

Appendix A

Survey questions

I would appreciate your time responding to one of my graduate students.

David Wright.

Full Professor.

Hi,

I am a graduate student working on a project that is part of the Federally funded Network of Centers of Excellence in Telelearning, which includes many universities and industry partners nationwide.

The project is to evaluate the use of the Internet tools and technologies for the development and delivery of education/training.

Please take a few moments to complete the following BRIEF survey.

When I have compiled the results, I will share them with all contributors.

1. Are you :

- ☐ A faculty member;
- ☐ Administrator;
- ☐ Other (please specify);

2) Would you describe your institution as:

- ☐ Community college;
- ☐ University;
- ☐ Professional training organization;
- ☐ Other (please specify);

3) Have you used any Internet tools in your course(s)?

- ☐ Yes;
- ☐ No;

4) If you have not used any Internet tools in you course(s), do you have any plans to do so within the next year?

- ☐ Yes;
- ☐ No;

5) Did you/will you use the Internet for teaching because: (choose as many as appropriate)

- ☐ It improves student-student communication;
- ☐ It improves student-teacher communication;
- ☐ It saves time;
- ☐ It is cost efficient;
- ☐ It makes student research easier;
- ☐ It enables to reach more students anytime and anywhere;
- ☐ Other reasons (please specify);

6) If you have used/will use the Internet in your course(s), what tools did you/will you use within the next year? (choose as many as appropriate)

- Present ☐ Next year ☐ : e-mail;
Present ☐ Next year ☐ : newsgroups;
Present ☐ Next year ☐ : listservers;
Present ☐ Next year ☐ : mailing lists;
Present ☐ Next year ☐ : World Wide Web;
Present ☐ Next year ☐ : IRC (Internet Relay Chat);
Present ☐ Next year ☐ : MUD (Multi User dimensions);
Present ☐ Next year ☐ : MOO (MUD Object Oriented);
Present ☐ Next year ☐ : CUSeeMe;
Present ☐ Next year ☐ : Other real time conferencing programs (please specify);
Present ☐ Next year ☐ : MBONE tools;
Present ☐ Next year ☐ : Other tools;

7) If you incorporate/will incorporate(within the next year) real time multimedia in your course(s) delivery, what media do you /will you include?

- Present ☐ Next year ☐ : audio only;
Present ☐ Next year ☐ : video only;
Present ☐ Next year ☐ : both audio and video;

8) How are you using/planning to use the Internet (within the next year) to deliver the course(s) material?

- Present ☐ Next year ☐ : student communication;
Present ☐ Next year ☐ : class discussions;
Present ☐ Next year ☐ : lectures (real time);
Present ☐ Next year ☐ : lecture material;
Present ☐ Next year ☐ : posting the course(s) outline;
Present ☐ Next year ☐ : hypertext student manuals;
Present ☐ Next year ☐ : receiving assignments;
Present ☐ Next year ☐ : providing student feedback;
Present ☐ Next year ☐ : cooperative assignments between students;
Present ☐ Next year ☐ : exams;
Present ☐ Next year ☐ : Other (please specify);

9) What advantages have you found to date from using the Internet for teaching/learning?

10) What disadvantages have you found to date from using the Internet for teaching/learning?

Thank you for your cooperation!

Rafa Kouki.

MBA student. University of Ottawa. Canada.

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Appendix B

List of Names Of the Selected set of institutions from “Yahoo! Internet Life” Survey.

- Massachusetts Institute of Technology. Cambridge, Massachusetts.
- North Western University. Evanston, Illinois.
- Emerson College. Boston, Massachusetts.
- Dartmouth College. Hanover, New Hampshire.
- University of Oregon. Eugene, Oregon.
- New Jersey Institute of Technology. Newark, New Jersey.
- Berkeley-University of California. Berkeley, California.
- Cornell University, Ithaca. New York.
- University of Michigan . Ann Arbor, Ann Arbor.
- New York University. New York, New York.
- Yale University. New Haven, Connecticut.
- Harvard University. Cambridge, Massachusetts.
- UCLA. Los Angeles, California.
- Stanford University. Stanford, California.
- Milsaps College. Jackson, Mississippi.

Glossary

- **ADSL (Asymmetric Digital Subscriber Line):** It is a technology for transmitting digital information at high speeds on existing copper phone lines to homes and businesses.
- **Anonymous FTP:** Using the FTP function of the Internet to anonymously access files, by not logging in with an actual, secret login ID and password.
- **Applet:** A mini Java program that can be accessed via the Web.
- **Application:** software that performs a particular function, such as e-mail or file transfer.
- **Asynchronous:** A mode of communication with time delay between statement and response
- **B-channel(Bearer channel):** In ISDN, the B-channel is the channel that carries the
- **Bandwidth:** The transmission capacity of the lines that carry the Internet's electronic traffic.
- **BRI: Basic Rate ISDN:** The standard ISDN line, consisting of 2 B-channels and 1 D-channel (i.e. one circuit on two wires with three channels.)
- **Bridge:** A device used to segment local area networks.
- **Browser:** Software that enables users to browse through the cyberspace of the World Wide Web.
- **Cable modem :**A cable modem is a device connected to or integrated in a computer, that enables users to receive information from the Internet over the local cable TV line.
- **CGI(Common Gateway Interface):** An interface-creation scripting program that allows Web pages to be made on the fly based on information from buttons, checkboxes, text input, etc.
- **Client:** A remote computer connected to a host or server computer. Also refers to the software that makes this connection possible
- **Cryptography:** A method used for secure communication dealing with the design of algorithms for encryption and decryption of electronic information.
- **CSU(Channel Service Unit):** A device that is placed at the end of a data circuit.
- **CUSecMe :** An Internet based real time video-conferencing tool used for inexpensive multipoint conferencing.
- **D-channel (Delta channel):** In ISDN, the D-channel is the channel that carries control and signaling information.
- **Dial-in/ dial-up access:** A type of connection that can link any computer directly to the Internet.

- **Digital signature:** A code used as an authentication mechanism to guarantee the integrity and the source of electronic messages.
- **DNS (Domain Name System):** A distributed data base system for translating computer names into numeric Internet addresses.
- **DSU(Data Service Unit).** A device that is placed at the end of a data circuit.
- **Ethernet:** A standard for transmitting data on local area networks.
- **E-mail(Electronic mail):** An Internet application which transmits messages from user to user. E-mail can contain text, but also can carry with it files of any type as attachments.
- **Electronic cash:** Money that exists only as information used to pay things over the Internet
- **Encryption:** A way of making data unreadable to everyone except the receiver.
- **Firewall:** a security tool used to prevent unauthorized to computer systems.
- **Freenet:** An organization committed to making Internet access available to the general public for free or for a small contribution.
- **Freeware:** Free software available on the Internet that can be redistributed.
- **FTP(File Transfer Protocol):** The basic Internet function that enables files to be transferred between computers.
- **Gateway:** A host computer that connects networks that communicate in different languages.
- **GIF(Graphics Interchange Format):** A graphics file format that is commonly used on the Internet to provide graphics images
- **Gopher:** A searching tool that was the primary tool for finding Internet resources before the World Wide Web became popular.
- **H.320:** A video standard that enables video conferencing.
- **Half-duplex :** Half-duplex data transmission means that data can be transmitted in both directions on a signal carrier, but not at the same time
- **Host:** A computer that "hosts" outside computer users by providing files, services or sharing its resources.
- **HTML(Hypertext Markup Language):** A coding language used to build hypertext documents for use on the World Wide Web.
- **HTTP(Hypertext Transfer Protocol):** The protocol (rules) computers use to transfer hypertext documents.

- **HTTPS (Secure Hypertext Transport Protocol):** HTTPS (Secure HTTP) allows you to get secure access to a Web site or certain pages on a Website.
- **Hyper-G:** Hyper-G is a publishing system with hypertext features more advanced than those available with HTTP and today's Web browsers.
- **Hypermedia:** Combination of hypertext and multimedia.
- **Hypertext:** Text in a document that contains links to other text in Web pages.
- **IP(Internet Protocol):** The rules that provide basic Internet functions. (See TCP/IP).
- **IP-Multicast:** a technique of multicasting on the Internet that allows data packets to be passed to multiple selected destinations.
- **IRC(Internet Relay Chat):** a real time communication Internet tool, the lets users join a chat and hold text based, and recently multimedia, conferences.
- **ISDN(Integrated Services Digital Network):** A set of communications standards that enable a single phone line or optical cable to carry voice, digital network services and video at high speed.
- **ISP(Internet Service Provider):** An organization that supplies Internet access and provides various kinds of Internet accounts to organizations and individuals.
- **Java:** An object-oriented programming language that allows the creation of portable multiplatform applications.
- **kbps--(kilobits per second)** A speed rating for computer modems that measures (in units of 1,024 bits) the maximum number of bits the device can transfer in one second under ideal conditions.
- **Kill file:** A list of newsgroup users whose postings users do not want to read. A user can create a kill file with e-mail addresses of people whose messages he/she do not wish to read.
- **Listserv:** An electronic mailing list utilized for e-mail driven forums and discussions.
- **Mailing list:** A discussion forum where all messages are sent to an e-mail addresses and then redistributed to e-mail boxes of the list subscribers.
- **MBONE(Multicast BackBONE of the Internet):** an Internet technology which allows multicasting over the Internet and used for real time multimedia conferencing.
- **MIME(Multipurpose Internet Mail Extensions):** An extension to the traditional Internet mail protocol that allows binary, or non-text, files, (i.e. graphics, executables, audio files etc.) to be sent as attachments to regular e-mail messages.
- **Modem:** An electronic device that lets computer communicate electronically by modulating and demodulating data over analog phone lines.

- **MOO:** MOO is an object-oriented MUD, that allow the manipulation and interaction with Cyber-objects in addition to chatting with other people.
- **Mrouter:** Machines (workstations or routers) that are equipped to support multicast IP.
- **MUD(Multi User Dimensions or Dungeons):** Interactive virtual worlds, where users can interact in real time using text or multimedia.
- **Netiquette:** The rules of etiquette that guide on-line interaction on the Internet.
- **Newsgroup:** A discussion forum on the Internet devoted to talking about a specific topic.
- **Newsreader:** Application software for reading and posting articles to newsgroups.
- **Password:** A secret combinations of letters and other symbols needed to login to a computer system.
- **Plug-ins:** A set of stand alone programs used to extend and enhance the browser's capabilities.
- **POP (Post Office Protocol):** A protocol used by e-mail clients to retrieve messages from an e-mail server.
- **PRI(Primary Rate ISDN):** An ISDN service that offers 23 B channels at 64 kbs and one D channel at 64 kbs (23B+D).(i.e. one circuit on four wires with 24 channels.)
- **Protocols:** Computer rules that provide uniform specifications so that computer hardware and operating systems can communicate.
- **Public key encryption:** A form of cryptosystem in which encryption and decryption are performed using two different keys: a public key and a private key.
- **QAM(Quadrature Amplitude Modulation) and QPSK(Quadrature Phase Shift Keying):** The two most popular modulation schemes used in cable modems.
- **RSVP(Resource Reservation Protocol):** A mechanism of reserving bandwidth on the Internet so as to provide good performance for real-time audio and video.
- **Server:** A host computer on a network that answers requests for information from it. The term server is also used to refer to the software that makes the process of serving information possible.
- **Shareware:** Software available for downloading on the Internet that you can try before you buy. Users who want to continue to use the program are expected to pay a registration fee. In return they get documentation, technical support, and any updated versions.
- **SLIP/PPP:** Serial Line Internet Protocol (SLIP) or Point to Point Protocol (PPP): a protocol that enables computers to connect, usually by dial-up modem, directly to other computers that provide Internet services.
- **SMTP(Simple Mail Transfer Protocol):** The basic programming language behind the Internet's e-mail functions.

- **Symmetric encryption:** A form of cryptosystem in which encryption and decryption are performed using the same key.
- **Synchronous:** A mode of communication in which participants can communicate in real time.
- **T1/T3:** Two types of Internet backbone lines that carry consecutively, 1.53Mps and 45Mbps.
- **TA(Terminal Adapter):** An electronic device that interfaces a PC with an Internet host computer via an ISDN phone line. Often called "ISDN modems."
- **TCP/IP(Transmission Control Protocol/Internet Protocol):** These are protocols that let different types of computers communicate with each other.
- **Telnet:** An Internet protocol that allows a computer to connect to a host computer anywhere in the world and to use that computer as if the user was logged on locally.
- **URL(Universal Resource Locator):** The combination of letters and numbers that identifies a Web resource.
- **VRML(Virtual Reality Modeling Language):** A programming language which allows constructing and viewing 3D environments.
- **WAN(Wide Area Network):** A communication network made up of a number of Local Area networks (LANs)allowing access to data physically located at widely diisparate distances.
- **WAIS(Wide Area Information Servers):** A distributed information retrieval system that is used to find information in databases or libraries across the Internet.
- **Web server:** A computer directly connected to the Internet that responds to requests form web browsers to send web pages.
- **Webmaster:** The person responsible for administering a Web site.
- **Whiteboard:** A window or monitor which can be shared between users for writing, drawing and displaying slides, e.g. in postscript format.
- **World Wide Web:** A hypertext based system which provides multimedia capability with the ability to link and cross-reference between sources of information. Also known as WWW or Web.

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