Section 5
Technology Tools and Needs
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5.0 Web-Based Education (WBE) Technologies Overview: an Introduction

The technologies involved in the execution and delivery of a Web-based course are varied. There is a demand for certain technologies and technical expertise at all levels of course delivery and a detailed overview of these is the focus of this section.

The technologies needed for the execution of WBE can be placed into three distinct categories: those technologies involved in the creation of Web-based course content, technologies involved in the delivery of WBE, and those technologies involved in the serving of Web pages. HTML editors, video and audio capturing technologies, and multimedia authoring tools are all examples of technologies involved in the creation of Web content.

The technologies involved in the delivery of WBE education fall into two categories that correspond to method of the communication delivery, synchronous or asynchronous. Synchronous communication describes the "real time" interaction between parties, such as a Web-based video or audio conference or chat. Asynchronous communication describes communication that is not based in "real time"; examples of this would be e-mail or even text displayed on a web page. There are also newer technologies such as streaming media that can conceivably be used to deliver audio or video content in either a synchronous or asynchronous manner.

The technologies involved in serving Web pages are those technologies, whether hardware or software, which are involved with the serving of HTML documents to the WWW.

There are also technologies concerned with the difficulties that arise when communicating via the Web. These would include the problem of bandwidth and technologies that deal with security and authentication.

The focus of section 5 is an attempt to give a basic overview of the technologies mentioned above. Also, we will devote a section of this document to a discussion of WBE “courseware” packages, the dynamic nature of multimedia delivery via the Web, and a brief assessment of the ways WBE technologies are being implemented in other programs around the country.

Also, we will give an assessment of the technologies currently owned by GSLIS that could be used for WBE. This will include an overview of GSLIS staff.

Finally, we will make recommendations for the use of certain technologies in GSLIS’s WBE program. These will include software, hardware, and staffing recommendations based upon the various kinds of course content which may be employed. We will also make recommendations for student technological requirements.

5.1 Creating Websites for Distance Education: Web Authoring Tools

The Web authoring tools are divided into the following categories:

- Internet-enabled authoring tools
- Multimedia authoring tools
    - Image Authoring
    - Animation Authoring
- Web publishing tools

For each category, one or two products are discussed in depth. These programs are selected based upon reviews by software magazines as well as a small response on the Distance Education Online Service (DEOS) listserv.

Helpful Terms and Definitions

In order to gain a better understanding of the tools and nature of these programs, some common terms are defined below. These terms appear frequently in the charts and appendices. All terms below are modified definitions based upon those provided by the Web site www.whatis.com.

ASP	*(Active Server Page) is an HTML document with embedded programs (scripts). The scripts are processed on a Microsoft Web server before they are sent to the user. A user may save an HTML with the ".asp" file suffix.*
BMP	*(bitmap) designates a display space and the color for each pixel or "bit" in the image. A GIF and a JPEG are examples of graphic image file types that contain bit maps. Bitmaps use a fixed or raster method of specifying an image, so the image cannot be immediately rescaled by a user without losing definition.*
CGI	*(Common Gateway Interface) is a part of the Web's HTTP protocol that communicates data (such as an online form) from the server to a small application program that processes the data and sends a message back to the user.*
CSS	*(Cascading Style Sheet) a style sheet derived from multiple sources with a defined order of precedence in cases where the definitions of any style element conflict. The page creator gains more control over Web page appearance.*
DHTML	*(Dynamic HTML) combines HTML tags with options, style sheets, and programming which allows the user to create more animated Web pages with more user interaction. A few examples of DHTML features supported by Netscape and Microsoft are as follows: an object-oriented view of a Web page, cascading style sheets, and dynamic fonts.*
FTP	*(File Transfer Protocol) uses TCP/IP protocols to transfer Web page files to the server and also for downloading programs from a server. FTP can be used in a simple command-line interface or with through a graphical user interface in a certain commercial product.*
GIF	*(Graphics Interchange Format) a common file format for graphic images owned by Compuserve. It is encoded in binary and uses LZW compression.*
GIF89a	*This type of GIF file enables the user to create an animated image that can be played after transmitting to a viewer page. The file contains a set of images to be presented in a specific order.*
IRC	**(***Internet Relay Chat) is a system for chatting that involves a set of rule and conventions and client/server software.*
Java	*is an object-oriented programming language. Programs created with Java are compiled into Java byte code that run anywhere in a network on a server or client that has a Java virtual machine. The Java virtual machine interprets the byte code into code that will run on computer hardware. As a result, individual computer platform differences can be recognized and accommodated locally as the program is being executed.*
JavaScript	*(from Netscape) is an interpreted programming or script language that is useful for shorter programs. JavaScript code can be imbedded in HTML pages and interpreted by the Web.*
JPEG	*(Joint Photographic Experts Group) this common graphic image type is created by choosing from a range of compression qualities.*
MP3	*(MPEG-1 Audio Layer-3) is a format for compressing a sound sequence into a smaller file that is usually one-twelfth the size of the original file. The original level of sound quality is preserved when it is played.*
ODBC	*(Open Database Connectivity) enables a user to access files from a number of different databases such as Access, dBase, DB2, Excel, and Text. Requires a separate driver for each database to be accessed.*
PNG	*(Portable Network Graphics) is a file format for compressed graphic images. The format is patent-free and reputed to have better qualities than the GIF format.*
Perl	*(Practical Extraction and Reporting Language) a script programming language that is primarily useful for developing Common Gateway Interface (CGI) programs due to its text manipulation facilities*
SQL	*(Structured Query Language) a standard, interactive programming language for retrieving and updating information in a database. The queries operate like a command language, allowing the user to select, insert, and update the data.*
Shockwave	*a family of multimedia players developed by Macromedia*
TCP/IP	*(Transmission Control Protocol/Internet Protocol) the basic language for communication of the Internet. The Transmission Control Protocol packages a message*

	or file into smaller segments to be transmitted over the Internet and received by a TCP layer that reassembles the segments into their original form. The Internet Protocol checks the address of the file or message, ensuring it reaches the proper location.
TWAIN	*A program for the purpose of scanning an image directly into an application in order to edit the image. The TWAIN driver runs between an application and the scanner hardware, enabling a faster transfer of the image from the scanner to the editing application.*
Vector graphics	*Digital images are created through a sequence of commands that place lines and shapes in two- or three-dimensional space. A vector file describes a series of points to be connected, rather than containing a bit in the file for each bit of drawing. This cuts down on file size.*
WYSIWYG	*(What you see is what you get) a type of editor or program that enables the user to create a graphical user interface in order to view the end result of the document as it is being created.*
XML	*(Extensible Markup Language) aids an individual in creating information formats for the purpose of easy sharing of data over the Internet. XML describes the content of a page according to the data being described.*

5.1.1 Internet Enabled Authoring Tools

Internet-enabled authoring tools are defined as, "Tools used to integrate multimedia elements and incorporate a logic of instructional interactivity, branching and scoring."[1] A key feature of these products is their "internet play" capabilities. All of the software in this category is equipped with a plug-in that enables the browser to interpret and handle various media files. As a result, bandwidth is saved, since students no longer must download an entire courseware package at once. The plug-in is still limited by the speed and bandwidth of the student's Internet connection.

The software listed in this category is currently the most competitive on the market. Some of the products in the table below are merely geared toward multimedia Web site production (Director, GoLive), while others design and integrate various learning applications within Web sites (Authorware, Quest Net+, Icon Author).

[1] TeleEducation New Brunswick. (1998). [Online]. *A Survey of new media development and delivery software for internet-based learning.* Available: http://teleeducation.nb.ca/media/environment/ [1999, 20 October]

	Macromedia Authorware 5.1	**Macromedia Director 7**	**Quest Net+**	**Aimtech/ Asymetrix Icon Author 7.6**	**Adobe GoLive 4.0**
Interface & Viewing Options	Drag-and-drop	Drag-and-drop for many functions	WYSIWYG Flowchart design; needs some icons	Alphabetical, not by function; unorganized	WYSIWYG drag-and-drop; too many icons; 2 window views for site structure & individual pages
Support	Active-X, SQL server, Animated GIFs; Quicktime 4 **Java applets difficult to integrate**[2]	Translates proprietary-code to JavaScript; offers a "save as Java" option; XML	Real-time communic.; online data transfer and file access; runs only on Windows OS	Active-X, Java, FTP; strong database handling	DHTML, XML, ASP, CSS, JavaScript
Templates Wizards & Resources	Templates-instructional files		Wizards and templates		External web links for help; Inspector palette checks URLs
Other Information	Proprietary scripted language	Proprietary scripted language (LINGO)	Requires knowledge of C programming		Some Browser compatibility problems

Macromedia Authorware
Macromedia's Authorware has a difficult learning curve, but once mastered, it is a powerful tool for creating learning applications.[2] The user must learn its proprietary scripted language, which accounts for the difficult learning curve. The interface has drag-and-drop abilities for improved efficiency in creating applications. The program includes numerous templates for instructional files. It also provides the instructor with the ability to track student responses. Multimedia creation is possible through the use of Dreamweaver. In addition to this, Flash 4 and Animated GIF files may be imported and controlled in Authorware. MPEG, WAVE, and other QuickTime formats can be integrated in Authorware applications. Streaming media may also be delivered in Authorware files. Some special features include the search and hyper linking ability for documents. The program may be combined with Active-X and SQL servers.

Macromedia Director
Macromedia's Director Instructor's Kit includes Fireworks, Sonic Foundry's SoundForge XP, and Shockwave. Shockwave enables the multimedia playback. Fireworks and SoundForge are useful for creating image maps and sound files. The behavior library contains a "drag and click" interface that simplifies functions such as assigning URLs or setting up chat rooms. Lingo, the proprietary code, may be translated to JavaScript. In addition to this, a tool allows the user to save an object as Java while creating an applet. The program also supports XML and can import

[2] Cornell, Gary. (1998). PC Computing. [Online] *Teach your office a lesson.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,283572,00.html [1999, 15 October]

Quicktime 3 and Flash movies. This product was rated four stars by PC Computing and is popular among distance-education professionals.[3]

5.1.1.1 Image Authoring Tools

There are numerous products available specifically for image authoring. Such products create files that can be saved in one of the common image formats. These image formats are JPEG, GIF, BMP, and TIFF. They are discussed and defined in the list of terms.

	Corel Draw 9	**Adobe Photoshop 5.5**	**Macromedia Freehand 8**
Interface & Viewing Options	User-configuration option; improved interface[4]	Photoshop and ImageReady have similar interfaces; LiveView panels preview up to four compression parameters; Images easily transferred from PS to IR, while retaining all attributes	Somewhat cluttered; Four customizable toolbars; Xtras palette includes basic tools, therefore not very organized[5]
Support	Automatic text conversion to HTML; Supports Twain and ixla Digital Camera plug-in; PDF format;	JavaScript; GIF animation; Photoshop & ImageReady linked for easy file sharing; Save for Web option	Insta-HTML for importing Web pages; Flash animation; Expanded GIF support and PNG support
Color Tools	Extracts colors from images; Can read ICC profiles of other applications to keep original color; Photo-paint effects	Color table with selection of Web-safe colors;	Options for mixing & hiding colors; Retains true color in printing; Web-safe color library; GIFs do not retain colors compared to other applications
Templates Wizards Inspectors Reference	Warning feature before printing; Reference links to help sites; "Prepare for Service Bureau" Wizard; Preflight tool inspects document for printing problems and offers solutions		370 project templates; Numerous tutorials & wizards
Other Features	Numerous pen styles, image sprayers, erasers, distortion tools; New texture and pattern transparencies in gradient tools; Thousands of pieces of clip art, photos, fonts	New format: Lossy GIF for images with many colors-compatible with regular GIF format;	400 fonts; text may be added to any object with various shaping & spacing options; Cannot set drawing scale or measure the diameter/radius of an image

[3] Carlson, Kyla K. (1999). PC Computing. [Online] *Two steps to a sexier site.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,405837,00.html [1999, 8 October]
[4] Grotta, Danial; Grotta, Sally Wiener. (1999). PC Magazine. [Online]. *Corel Draw 9.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,406508,00.html [1999, 24 October]
[5] Ozer, Jan. (1998). PC Magazine. [Online]. *Freehand 8.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,344552,00.html [1999, 25 October]

Adobe Photoshop
Adobe Photoshop, version 5.5, includes ImageReady 2.0, which enables JavaScript and GIF animation. Files may be easily shared between ImageReady and Photoshop. The two programs have similar interfaces, so that ImageReady is not difficult to use if one understands Photoshop. ImageReady includes tools for easy creation of image maps, JavaScript rollovers, and animation. Images may be passed from Photoshop to Image Ready while still retaining all characteristics. Photoshop allows the user to view images as they appear to different browsers. In addition to this, FIG, JPEG, PNG8, and PNG24 files may be viewed by various characteristics such as file size, compression, and download times. A user may choose predefined compression settings. When selecting colors, the user may refer to a selection of Web-safe colors. In addition to this, the user may preview the appearance of 8-bit images among different browsers and operating systems. Photoshop includes a new format, the Lossy GIF, which is compatible with regular GIF files and enhances color. The user has control over the level of "lossiness" in a GIF compression, which helps cut down on file size. Animation is also possible by creating new frames or layers to be compiled as an animation. The learning curve for this program is very difficult, but it is among the most popular programs for image authoring.

5.1.1.2 Animation Authoring Tools
Animation software creates files according to the most common animation file formats: GIF89a, Java, Shockwave, which are discussed in the list of terms. The two most common products on the market are Macromedia Flash 4 and Macromedia Director 7, discussed above in the *Internet-Enabled Authoring* section. Animation is also possible through the use of Adobe Photoshop, discussed above.

Macromedia Flash 4
Macromedia Flash creates animation, either through use of Flash drawing tools, or by importing artwork from other vector-illustration programs such as Freehand. Flash creates higher quality animation with smaller file size.[6] The application uses vector graphics instead of bitmap, which accounts for the smaller file sizes. Flash animation plays while it is being downloaded, so that playback is smooth, even for slower Internet connections. Bitmap files may still be imported and converted to vector graphics. The application can also export GIF files for users that do not have the Flash plug-in. MP3 is used for the sound files, allowing the user to create streaming audio. Flash's interface has improved since its earlier versions, enabling the user easy access to the most common functions.[7] Some of the more complex actions are difficult to create.[8] In fact, the program is difficult to learn unless the individual is familiar with Macromedia's Director.

5.1.2 Web Publishing Tools
In order to integrate the types of multimedia files discussed above, a Web publishing program is necessary, because the material must be presented in HTML format. The most popular products according to the DEOS questionnaire are Microsoft FrontPage, Macromedia Dreamweaver, Adobe PageMill, and Adobe GoLive.

[6] English, David. (1999) Computer Shopper. [Online]. *Flash 4: making great impressions.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,2327072,00.html [1999, 25 October]
[7] PC Magazine. (1999). [Online]. *Interface improvements.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,2292872,00.html [1999, 15 October]
[8] Simone, Luisa. (1999). PC Magazine. [Online]. *Macromedia Flash 4.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,2292758,00.html [1999, 15 October]

	Claris Home Page 2.0	Adobe Pagemill 3.0	Microsoft FrontPage 2000	HotMetal Pro 5.0	Dreamweaver 3
Interface	WYSIWYG Simple interface[9]	WYSIWYG Improved interface[10]	WYSIWYG Combines navigation & editor views	WYSIWYG includes graphical** & tags-on*** modes	WYSIWYG Each element has its own properties window; Site & Page Views
Support	Database connectivity; Built-in FTP tool; **NO support for DHTML or CSS**	Java applets in editing window; **does not read JavaScript**	Word, Excel, & PowerPoint files may be saved directly to FrontPage; CSS	XML	Imported HTML; DHTML, RealVideo & HotMedia
Templates Wizards Reference	Assistants for creation process;	No templates for page consistency; No wizards-HTML files must be built from scratch or imported	Style wizards & templates	Site-maker template; Attribute Inspector (does not work in Source Mode)	Can create templates; Templates separate content from design
Editing	Cannot delete pages or rearrange site without MS Internet Explorer; Global search & replace tools	Search & replace feature; Source code editor displayed in WYSIWYG-inconvenient	Does not modify hand-coded HTML;	Edits pages with Source*, Graphical**, or Tags-On*** Modes	Control over HTML editing Search & replace tools

*Source Mode color codes HTML as user enters tags.
**Graphical Mode allows the user to drag and drop objects directly onto the page without writing code.
***Tags-On Mode shows which tags affect which objects by using a graphical view.

Microsoft Frontpage

Microsoft Frontpage 2000 has a WYSIWIG interface and includes numerous style wizards and templates. The view window represents the page as a chart. Another option allows the user to view HTML tags while still in Normal view, through the use of the Reveal Tags option. Navigation and editing views are conveniently combined. Microsoft Word files may be imported, often with no formatting loss. In addition to this Word, Excel, and PowerPoint files may be saved directly to a FrontPage site. When pages are added or rearranged, links and navigation bars are automatically updated. This is not the case with many Web editors. Tools include a Web-safe color selection and CSS positioning. DHTML effects may be easily integrated in Web pages. The user may edit the HTML, and FrontPage does not modify the hand-coded portion. The product includes over 60 pre-designed business themes to give a consistent look and feel to a particular Web site. These themes may be customized by the user. Frontpage supports ODBC-compliant databases, and the Database Results Wizard displays database contents within a Web page. The program includes many advanced features, but it is also easy for novices. This program was the Editor's Choice in PC Magazine.[11]

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[9] Lynch, Jim. (1999). Windows Sources. [Online]. *Home Page makes site building quick and simple.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,279611,00.html [1999, 15 October]
[10] PC Magazine. (1998). [Online]. *Adobe PageMill 3.0.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,313969,00.html [1999, 25 October]
[11] Ozer, Jan. (1999). PC Magazine. [Online]. *Microsoft Frontpage 2000.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,402287,00.html [1999, 15 October]

Macromedia Dreamweaver 3
Macromedia's Dreamweaver grants the user much power over the program. It has a WYSIWYG interface with a site view as well as a page view. The interface includes floating toolbars, palettes, and libraries, and every element contains its own properties window. A key feature in this product is the user's ability to create templates. In addition to this, the user may specify the areas of the template that are editable or not. The Dream Templates separate content from design. This makes the updating process simpler for the user. Many tools are included such a drag-and-drop table editor, search and replace options, and Web-safe color schemes. Though the product supports CSS, a creator has the ability to convert layers to table format for non-CSS browsers. Dreamweaver also supports a wide variety of DHTML effects that include a timeline in order to control movement for animated objects. A weakness to Dreamweaver is the fact that the graphics tools are not very efficient.[12] In addition to this, the learning curve is somewhat difficult, unless one is experienced with another Macromedia product.

5.2 Web Content Delivery Technologies

The technologies involved in the delivery of Web-based content fall into two categories of communication, asynchronous and synchronous. Asynchronous communication does not require that all parties involved in the learning experience be available at a set point in time. Asynchronous communication enables a user to access and pass along information when it is most convenient for her. This is one of the most attractive aspects of WBE, because it allows for the various schedules that students have. Students may choose to access class information at any time and can structure their learning experience to their own lifestyle and learn at their own pace. Examples of asynchronous communication include: e-mail, file sharing, message boards, video or audio clips, and text.

Synchronous communication is more akin to the traditional classroom experience, because participants must connect at a designated time in order to receive or exchange information. Students who wish to have "real-time" contact with the instructor or other class members would find the inclusion of synchronous communication in their WBE experience to be greatly beneficial. Instructors will find that synchronous communication between themselves and their students will enable them to gauge student progress throughout a course. It will address those individuals who need more experience more traditional modes of communication in order to grasp fully the information presented. Questions may be asked and answered as they arise, which will allow for increased confidence that the information presented is having its desired effect. Examples of synchronous communication via the WWW include,chat, white boards, real-time file sharing, and audio-video conferencing.

5.2.1 Asynchronous Communication Tools

Web-based Discussion Software
Though file-sharing and asynchronous communication are possible through the use of e-mail, discussion boards can be useful for WBDE, because they provide a central point for a class to participate in organized, moderated forums. There are several commercial products available for asynchronous communication. These products are mainly discussion-board software types. The five products compared in the table are chosen based upon reviews by PC Magazine.[13] Several of the products listed in the table below have other tools such as HTML editors and live chat. However, the table focuses upon the basic features of most Web discussion boards: administrative tools, filtering control, user navigation, and message features. Two of the products are discussed at length, due to referrals of these items from the DEOS listserv.

[12] Schwerin, Rich. (1999). PC Magazine. [Online]. *Build your dream site.* Available: http://www.zdnet.com/products/stories/reviews/0,4161,405830,00.html [1999, 8 October]
[13] PC Magazine. (1998). Networking- Meeting of the Minds. [Online]. *Discussion software- summary of features.* Available: http://www.zdnet.com/pcmag/features/discussion/features.htm [1999, 15 October]

	Administration	Filtering	User Navigation	Messages
WebBoard 4.0 Windows 95/98, NT 4.0 **$1199**	Sets user-level access to read-only, read/post/ delete, & create/delete forums	Admin. can delete/archive messages	Can perform full-text & fielded searches; can collapse & expand threads; can create or modify a forum	Can include attachments & links
Web Crossing 3.0 Windows 95/NT Unix **$695** for 20,000 messages	Sets user-level access to read-only, read/post/ delete, & create/delete forums	Admin. can delete messages;	Can perform full-text, fielded, and Boolean searches; can create or modify a forum	Can include bullets and links
Expressions Interaction Suite 3.0 Windows NT, Solaris 2.5 **$795** for 50 users	Sets user-level access to read-only, read/post/ delete	Admin. can delete/archive messages; deletes/replaces profanity	Can perform full-text, fielded, and Boolean searches; can collapse & expand threads; can create or modify a forum	Can include bullets, attachments, & links
Message Boards Windows NT4.0, Unix **$2995** for 50 users	Sets user-level access to read-only, read/post/ delete, & create/delete forums	Admin. can delete/archive messages; deletes/replaces profanity or rejects entire message	Can perform fielded searches; can create or modify a forum	Can include bullets & links
Proxicom J/Forum Windows NT 3.51, Solaris 2.51 **$7500** 10 forums	Sets user-level access to read-only, read/post/ delete, & create/delete forums	Admin. can delete/archive messages	Can perform full-text & fielded searches; can collapse & expand threads; can create or modify a forum	Can include bullets, attachments, & links

O'Reilly WebBoard 4.0

In addition to the tools described above, WebBoard has many useful features for effective asynchronous communication. It includes a Web-based discussion server, a chat server, and a mailing list server, though the software itself may be installed on non-Web servers. The product also includes built-in database software, though it may be integrated with an SQL Server 6.5 or 7.0. In addition to this, it includes 1,000-user Internet Relay Chat (IRC) capabilities. The software includes an authoring tool with a wizard for Web-page creation. The administrator may customize boards according to the particular needs of the forum. New features to the latest version of WebBoard include Microsoft standard databases and open scripting. The administrator may install the software with the aid of a wizard, or s/he has the option of performing a custom installation. Users have the option to edit, delete, and preview messages. Users may also engage in real-time chat. A special email notification tool alerts a user if s/he has a new message.

Web Crossing 3.0

Like WebBoard, Web Crossing also has built-in database software and includes the option of custom or wizard-based installation. In addition to the forums, it also includes integrated, real-time chat. The entire user interface may be customized. The administrator may also add new fields to directories, folders, discussions, and messages. Many templates are available for customizing color, graphics, text, frames, and buttons. The discussions in Web Crossing software are organized with the use of folder icons that may also be nested, for navigation purposes. The

administrator has control over access to designated folders as well as the creation of folders. Options for user authentication are possible through the use of a basic HTTP cookie. Administration may be accomplished remotely with the use of any Web browser. The product has a proprietary scripting language (WCTL) that may be learned fairly easily by an experienced administrator. Users may choose between viewing the discussion in a threaded or linear view. One drawback to Web Crossing is that it currently has no support for embedded attachments; however users can attach files to discussions within a conference. Web Crossing supports all Web browsers.

Free Products
Numerous discussion boards are available free of charge. Examples of these are listed as follows:

ActiveForum	http://www.iasoft.com/default.asp
Ceilidh	http://www.lilicoi.com/
Discus	http://www.mulliken.chem.hope.edu/discus/home/
HyperNews	http://www.union.ncsa.uiuc.edu/HyperNews/get/hypernews.html
meep!Board	http://www.meep.com/product/
MHonArc	http://www.oac.uci.edu/indiv/ehood/mhonarc.doc.html
Ultimate Bulletin Board	http://www.prime-web.com/compass/ultbb10.html
VBS v5.1 Beta	http://www.ebbs.english.vt.edu/~daughert/vbs/
WWWBoard	http://www.worldwidemart.com/scripts/wwwboard.shtml
WWWThreads	http://www.screamingweb.com/wwwthreads/

5.3 Synchronous Communication Tools

Synchronous communication occurs in real time with participants dynamically responding to each other. Asynchronous communications allow participants to make responses to one another at different times. The following lists shows popular Web-based communication mechanisms categorized into synchronous and asynchronous communication.

Asynchronous	Synchronous
Email	IRC (Internet Relay Chat)
Listservs	MUDs/MOOs
Newsgroups	Shared Whiteboards
Mediated Discussions	A/V Teleconferencing

These mediums support multiple paradigms of communications. One-to-one, one-to-many, many-to-one, and many-to-many models of communication are supported.

5.3.1 CONFERENCING TECHNOLOGIES
Conferencing uses audio and/or video signals, which are transmitted to provide synchronous interactive communication or communication between two or more sites. Like television, the type of transmission and the nature of the signal can vary.

Any description of discrete types of conferencing technologies is problematic, given the rapid convergence of related technologies. For this reason, the typography offered below is offered only as a guide to readers unfamiliar with conferencing technologies.

Transmission can be point-to-point or point-to-multipoint (which reduces the degree of interaction between individual learner and teacher) by means of:

1. ISDN (integrated digital services network) lines supplied by Telkom;
2. Cable (for example, telephone lines supplied by Telkom);
3. Optical fibre (supplied by Telkom) for broadband transmission;
4. Satellite; or

5. Microwave transmission along line-of-sight.

There are various types of conferencing systems.

5.3.1.1 AUDIO CONFERENCING

Technical Requirements
At a technical level, audio conferencing consists of: a telephone (handset or speaker phone) that can be used by a group of learners; a telephone network that links these telephones (typically a standard dial-up telephone land line); and a mechanism which links these various telephones (typically a conference call service).

At an educational level, audio conferencing is usually facilitated by an operator trained in support of such technology use.

Use in Distance-Education Delivery
Some of the disadvantages of using audio conferencing to support distance education include:
- Its reduced user-friendliness in comparison to face-to-face contact between learners or learners and facilitators;
- Its potential to be an immensely tiring experience, especially if using traditional hand-set telephones;
- Sound quality is dependent on the quality of the worst line in the conference.
- Unless facilitators deliberately use techniques to ensure participation, a student could die in the middle of the conference and no one would know.

5.3.1.2 VIDEOCONFERENCING:

Videoconferencing allows people to communicate face-to-face without the tremendous cost of travel (airfare, hotels, rental cars, food, etc.). Using videoconferencing, people can assemble in their normal conference room with one or more cameras and microphones and get their work done without the time and expense of travel.

How It Works
The popularity of videoconferencing has increased dramatically over the past few years. This is primarily due to the availability of desktop videoconferencing (DTVC) which offers add-on products for most PCs. A typical DTVC consists of a board which digitizes and compresses a video signal. This signal is decompressed at the receiving station where it is reconstructed to resemble the original information. Compressing and decompressing DTVC information is accomplished using a CODEC (COmpression - DECompression) scheme. This is done with hardware or software. The more information that can be compressed, the larger and smoother the video images are on the receiving end. A basic DTVC system is shown.

Camera Information
Most DTVC boards accept standard camcorder video. The camcorder can be set on a tripod and placed to look at a panel of people. This is rather boring but can be made more interesting by having someone run the camera.

Monitor-top video cameras are popular for the more conventional face-to-face meetings. These miniature cameras sit on top of a computer monitor and are fixed on the person seated before the computer. These can be purchased for about $150 and produce surprisingly good images. Don’t expect them to work for meetings in large rooms; they have a narrow field of view and relatively short depth of focus.

Speaking Words of Wisdom
A microphone and loudspeakers are also part of a DTVC system allowing two-way conversations to occur. The microphone and the DTVC board allow the speaker’s voice to be digitized and compressed. A good microphone (for about $100) placed centrally in a meeting room can pick up all the voices. Like multiple cameras, several microphones can be used and mixed together. This is typically necessary in very large rooms with more than 25 people. Try to avoid clip-on microphones; they pick-up every slight movement and offer poor audio quality at best.

Loudspeakers are used to reconstruct the captured voices on the receiving end. Most SoundBlaster-compatible boards and their supporting speakers work just fine with DTVC. An external amplifier and speakers can be added to the "Line Out" connection (available on most audio boards) for coverage with large groups.

The Communication Line
The compressed audio and video signals are then sent over a communication line to the other computer involved with DTVC. The most popular communication line to transmit and receive data is the Plain Old Telephone Service (POTS). It's everywhere and that's what makes it a logical choice to use. The problem with the conventional telephone line is its limited bandwidth. Bandwidth refers to how much information can be sent back and forth. With the POTS, that's not much.

Originally intended for voice only, the telephone line does not handle video signals very well. Because video contains much more information than audio, it requires a much larger bandwidth (a larger information carrying capability) to handle this complex signal. What helps this situation is the fact that the audio and video signals are compressed before they are sent. This limited bandwidth can cause several problems including:
Choppy video - Jerky delays in the movement of an object.
Sync problems - Voices are heard when the mouth isn't moving.
Poor image quality - Low resolution images that are hard to see.

A more efficient option is using a dedicated line for high-speed and wide-bandwidth communications known as an ISDN (Integrated Services Digital Technology) line. Many larger corporations elect to connect with these lines since they can handle a tremendous amount of information. There is typically a one-time connection fee which includes physically installing the ISDN cable and connections followed by a fee for actual line usage.

DTVC Software
DTVC software typically offers more than just a means to see and hear someone else. Most DTVC software packages come with an "Electronic Whiteboard" feature. This allows notes to be taken on a blank "Whiteboard" next to the video image, as shown here.

Notes in the form of text are entered using a standard computer keyboard. These notes can be saved as an electronic file to be used later with most word processing programs.

File transfers can also be supported with many DTVC software packages. Perhaps after a financial meeting ends, the accounting information which has just been reviewed needs to be sent to a regional office. This electronic file can be selected and transferred either after the videoconference meeting has ended or, if you're using an ISDN line, in the background while sight and sound information is still being exchanged.

Another software feature that may be included is a zoom capability to allow an image to be magnified (but with a loss of image resolution). Drawing tools are sometimes included for adding very basic sketches to the electronic whiteboard. Audio mute may be a useful feature when private group discussions must precede a formal answer or announcement.

5.3.1.3 VIDEOCONFERENCING SOFTWARE:
Here are some examples of desktop videoconferencing software being used by educators:
1. CU-SeeMe
2. Intel Internet Video Phone
3. Intel ProShare
4. Microsoft NetMeeting
5. VDO Phone
6. Connectix VideoPhone

The Purdue University's CadLab videoconferencing testbed at

http://www.ccm.ecn.purdue.edu/information/research/projects/videoconf/
evaluates videoconferencing software and products. You can search their database of evaluated video conferencing products, as well as sign up for a videoconference, and view links to documentation.

5.3.1.4 CAMERAS:
Below is a list of some cameras which can be used for Web conferencing:
1. **Philips/Maganox PCA646VC USB PC Camera PRICE** $ 89.99

Can be used for desktop video conferencing, video-mailing, still imaging and many other imaging activities. The camera can be used by plugging it into a free USB socket. There is no need to install sound cards, grabber cards and separate power supplies. Power is supplied directly to the camera through the USB cable and returns audio and video straight to the PC.
REQUIREMENT Pentium 166 or higher and Windows 98

2. **Logitech Quick Cam VC** **PRICE** $130.00

Can be used to for desktop videoconferencing, take pictures, record videos, and create simple animations. It can be connected to the USB socket on a PC. The software includes VideoPhone software, which works with other videoconferencing software and Microsoft's Netmeeting.
REQUIREMENT 16MB RAM; 50MB hard disk space; Windows 95 (with Revision B or C and with USB supplement) or Windows 98

3. **3Com HomeConnect PC Digital Camera** **PRICE** $130.00
Can be used for business-based video conferencing, still image capture, and video creation. It can be connected to the USB socket on the PC. The product is bundled with a software suite which includes PictureWorks, Technology's PictureWorks Live for still image and video capture, PictureWorks Netcard for video e-mail, Microsoft Netmeeting, Kolban's Webcam32 and Real Networks' G2 Player for streaming audio and video.
REQUIREMENT 32MB RAM, 29MB hard disk space, USB port, Windows 95 OSR/2 (950b with USB supplement) or 98

4.**KODAK DVC 325** **PRICE** $130.00

The software bundled with this product is Microsoft NetMeeting (this for-free conferencing software is a standard component of almost every Webcam bundle), Presto VideoWorks and Presto Mr. Photo, video- and still-capture titles, respectively. Other features include video email.

5. **Xirlink C-It Mobile PC Camera** **PRICE** $120.00

Can be used to send video mail and videoconferencing. The video mail software, C-It Mail, lets you automatically attach still or video shots to your email. For teleconferencing, Xirlink includes the standard Microsoft NetMeeting, ensuring that most PC users will be able to receive your transmission.

6. **Aopen VC324 USB** **PRICE** $99.00

Can be used for taking snapshots and videoconferencing. It comes with its own software, the Aopen software.

7. **ACS Compro Plug-n-Snap PS 39U USB** **PRICE** $140.00

Can be used for grabbing single frames for photos and videoconferencing. Bundles with Microsoft's Netmeeting.

8. **Intel Create & Share Camera Pack USB** **PRICE** $129.00

Can be used to take snapshots, make short movies, place video calls, videoconferencing, create both email postcards and entire Web pages from images.

A more detailed review for Webcams can be found at *http://computers.cnet.com/hardware*

5.3.2 Video Conferencing in Distance Education

Apart from their applications in business, videoconferencing systems are often used for distance learning, linking distant teachers and learners for instruction. Here are a few ways videoconferencing might be used for instruction:

- Students can take classes not offered at their school, such as advanced honors or foreign language courses.
- Classes can communicate first-hand with experts in many fields to enhance understanding of a subject they are studying.
- Schools and community colleges can offer classes during off-hours and to students who cannot attend traditional classes.
- Community colleges can team up with businesses to offer employee training or certification.
- Teachers can team-teach with remote teachers, sharing subject matter expertise or a unique approach to a topic.
- Students can meet with tutors for enrichment or personal attention.
- A librarian could offer an introduction to library services and a library tour for local schools.

BENEFITS

As an interactive communication medium, two-way video stands out in a number of ways. First of all, it is almost like being there. The visual connection and interaction among participants enhances understandin and helps participants feel connected to each other. This goes a long way toward building relationships in a way that e-mail, telephone, or online chat systems cannot, supporting collaboration among traditionally isolated institutions. A videoconference can improve retention and appeal to a variety of learning styles by by including diverse media such as video or audio clips, graphics, animations, and computer applications.

Educators and librarians from around the country report that videoconferencing technology impacts student learning in the following ways: Heightens Motivation Improves communication, presentation, and "SCANS" skills

- Students perceive video guests as important and are more conscious of their appearance and oral communication.
- When students plan and implement the videoconference, they learn important communication and management skills.

Increases Connection with the Outside World

- In some cases, a live visit is not possible, though at least one face-to-face visit is recommended if an ongoing relationship is important and if it is feasible.
- Videoconferencing is usually easier than visiting, so communication can be more frequent, saving time and resources.
- Students have a greater opportunity to form meaningful relationships with children who may be very different from them.
- The richness of the communication supports the formation of relationships between learners and mentors/role models.

Increases Depth of Learning

- Students learn to ask better questions
- Learning is from a primary source rather than from a textbook
- Students show more depth in understanding
- Necessary planning contributes to better learning experiences.

5.3.3 VIDEOCONFERENCING TECHNOLOGY LINKS

Below are some useful links for further reference about videoconferencing.

1. Charles Hendricks' Desktop Videoconferencing FAQ at http://www.bitscout.com/faqtoc.htm covers standards, how to’s, hardware and software, and more.

2. The Videoconferencing Testbed at CadLab at *http://www.ccm.ecn.purdue.edu/information/research/projects/videoconf/* exists to evaluate current Videoconferencing packages, and develop a multi-platform videoconferencing system for the Engineering Research Center and its partner entities. Their Videoconferencing Database is searchable and will help you zoom in on systems that support the features you need.
3. Mike Pihlman's Desktop Videoconferencing Challenge article at http://newmedia.com/NewMedia/95/11/td/vidconf/Desktop_Videoconferencing.html is an excellent introduction to desktop videoconferencing and offers an old, but still useful, introduction that should help anyone getting started in videoconferencing.
4. SUCCEED's desktop videoconferencing Product Descriptions at http://www3.ncsu.edu/dox/video/products.html reviews some common desktop systems. Their Product Survey at *http://www3.ncsu.edu/dox/video/* offers additional information.
5. Pacific Bell's ISDN User's Guide at http://www.pacbell.com/products/business/fastrak/networking/isdn/info/isdn-guide/index.html offers a comprehensive look at ISDN.
6. The California ISDN Users' Group at *http://www.ciug.org:8080/* shares newsletters and other information.
7. news:comp.dcom.videoconf is a newsgroup for desktop video conferencing.
8. The IP Revolution Reaches Videoconferencing at *http://newmedia.com/NewMedia/98/09/frontline/IP_Video_Conference.html* is NewMedia's August, 1998 article about IP-based videoconferencing.

5.3.4 Web-Based Audio Conferncing (CHAT)

IRC CHAT
Internet Relay Chat is an Internet standard for conducting synchronous (real-time) multi-person text-based chatting. Most IRC chat applications are entirely independent of the web, but some can be launched from a Web page. For example ichat, a plug-in for Netscape Navigator and Microsoft Explorer supports IRC chat from within a frame in the browser window. Some common IRC Chat applications include:
1. ichat
2. Pow Wow
3. LiveChat
4. The Cafe
5. Global Chat

WEBCHAT
Web- based chat is more recent and, by definition, is more integrated with the Web. They offer multi-party, synchronous (real time) chat and some offer other functionality like private chat lines, moderator control, and audio chat. Some examples are:
1. ichat ROOMS
2 WebBoard
3. WebChat
4. AltaVista Forum
5. Xpound

5.4 Streaming Media

Streaming media is a more recent arrival on the Internet that promises to bring with it seamless multimedia capabilities the likes of which have yet to be truly harnessed through use of the Web. Streaming technologies seek to make the most out of the current client/server relationship that exists on the Web by delivering media, such as audio or video, in a way that compensates for the typically large size of such files. To understand just how streaming technology does this it is necessary to take a quick look at the current Web host-user relationship and what problems this relationship may pose in the delivery of media-rich files.

Typically, a Web server responds to a request for information as quickly as possible in order to complete the transaction and disconnect from one user and move on to the next request for information. In this sense, Web servers are often referred to as being “stateless” because they move from client to client without ever spending too much time on just one request. Similarly, a Web user’s browser will typically take the information received from the server and then ignore the server until the next hyperlink is engaged.

This noncommittal relationship between host and user works well for the delivery of more static media such as graphics and text because the file size of such information is usually relatively small. However, when dealing with more dynamic media types, such as animation, video, or sound, which have a specific time component, this “stateless” approach can create some problems. This is because the time component of these dynamic media types causes their file size to be significantly larger than the typical text or graphic file. This increased file size combined with the “stateless” relationship between user and host means that a user must download an entire video or sound file before it can be played. The wait that a user must endure before even a relatively small video or sound file can be played can often be extremely long and frustrating. The goal of streaming media is to remedy this frustration by eliminating the wait before one of these larger files can be played.

Streaming technology does this by enabling users to view media while it is being fed to them by the host server. In order to do this, streaming media create more of a continuous connection between the users and host. During this connection portions of these larger files are fed continuously to the user until the entire file has been viewed. Thus, while viewing an early portion of the file a later portion is in the process of being downloaded. While this continuous connection does help alleviate some of the problems with file size, it does not completely eliminate it. To solve the problem, compression technologies are used which allow the efficient transfer of these large files. However, the compression technologies that are used significantly decrease the quality of audio or video using a streaming format.

It must be noted that the use of a continuous connection and the compression technologies mentioned above does not fully compensate for those users who have slower or lower bandwidth connections. More often than not these users will still experience problems in downloading these larger files, resulting in garbled audio or distorted video. Luckily, several products available in the streaming marketplace today allow streaming media viewers to save files as they are being downloaded for playing at a later date.

There are three major contenders in the area of streaming media technologies, RealTechnologies, QuickTime 4 by Apple Computers, and Microsoft Media Player. Each of these has its own merits and disadvantages and will be briefly discussed below.

RealTechnologies

RealNetworks has become the de facto standard of streaming media, accounting for over 85% of the streaming media marketplace. Its RealMedia player, now available in the 7 version, is available as a free download from the company’s Web site. The player handles audio, video, animation, still images, and text. For better control of video picture and sound enhancements users may download a $29.99 upgrade to the Plus version of RealPlayer 7 which also provides built-in MP3 support.

Also free at the company’s web site is RealProducer, software used to create streaming content for the RealMedia player. For about $150 there is also an upgrade available to RealProducer Plus G2 for streaming media creators who wish to create more dynamic media content.

Also available as a free download is RealSlideshow. Realslideshow can be used to creat basic Web-based slideshows that combine images with audio or music. There is also a Realslideshow Plus G2 version available for $29.99.

On the server side RealNetworks offers its free Basic Server G2, which supports 25 streams (simultaneous users) at a time. There is also the Basic Server Plus, which offers 60 streams and retails at $1995. For an additional $295 users may purchase RealFlash which streams Macromedia Flash Animations. For those with more formidable streaming needs a 100-user server costs around $6000, or for those expecting a lot of visiters a 400-user server will run about $24,000.

One of the most attractive aspects of the RealPlayer is its support for the WC3's Synchronous Multimedia Integration Language (SMIL). SMIL is a XML-based language that allows you to time and position media within the media player. Thus, a host may post a video or slide presentation with a synchronized audio file. SMIL is also important because it can be used to provide access to users who are hearing or visually impaired by displaying either a text file or audio file to accompany a video depending on the user's preference. (http://www.realnetworks.com/)

QuickTime 4

The basic QuickTime player is available as a free download from the Apple Web site. It is also included by default in the operating system of currently shipped Macintosh computers. Like the RealPlayer, an upgrade to the QuickTime Pro version of the player is available for $29.99. The Pro version provides basic editing and content creation tools for users who would like to create their own streaming media using the QuickTime system.

The major strength of QuickTime 4 is the wide array of formats it supports. The following is a brief list of some of these formats.

SUPPORTED IMPORT FILE FORMATS
Digital Video: QuickTime Movie, DV, MPEG, OpenDML, SDP, Video for Windows (AVI)
Digital Audio and Text: AIFF/AIFC, AU, Audio CD Data (Mac), Wave, DV, MPEG 1 Layer 1, MPEG 1 Layer 3, Sound Designer II, System 7 Sound, Text
Still Image: BMP (Windows Bitmap), FlashPix, GIF, JFIF/JPEG, MacPaint, Photoshop, PNG, QuickDraw GX Picture, QuickDraw Picture (PICT), QuickTime File, Silicon Graphics Image File, Targa Image File, TIFF
Animation and 3D: 3D Meta File (3DMF), Animated GIF, Macromedia Flash, PICS
MIDI: Stabdard MIDI, General MIDI, Karaoke

SUPPORT EXPORT FILE FORMATS:
Digital Video: DV, QuickTime Movie, Video For Windows (AVI)
Digital Audio and Text: AIFF/AIFC, AU, Wave, System 7 Sound, Text
Still Image: BMP (Windows Bitmap), MacPaint, Photoshop, QuickDraw Picture (PICT), JFIF/JPEG, TIFF, Targa Image File, Silicon Graphics Image File, QuickTime Image File, PNG
Animation and 3D: AutoDesk Animator (FLC) (http://www.apple.com/quicktime/authoring/fileformats.html)

On the server side, Apple has chosen to release its streaming technology as an open source project. The only glitch is that the code it currently provides only compiles for the Mac OS X and Red Hat Linux 5.2 server platforms. However, it is free for an unlimited number of users.

One of the few drawbacks to using QuickTime streaming technology is that some believe that it does not provide quality transmission in a live format. However, pre-recorded streaming content is perceived to be quite good.

Windows Media Player

All the tools needed to view and create Windows Media and the Advanced Streaming Format are available as free downloads from the Microsoft Web site. The Windows Media Tools download comes with the Windows Media Author which is highly a effective streaming-media authoring tool which, when used in conjunction with other programs such as Microsoft Power Point and Adobe Premiere, can create quite effective multimedia presentations. The Microsoft Media Player is just as powerful as RealPlayer or QuickTime; however, there are certain proprietary issues concerning the server software which must be used for the Advanced Streaming Format and with the platforms on which the Media Author will operate.

To begin streaming using the Microsoft's Advanced Streaming Format, users will need Windows Media Services running on their Web servers. Windows Media Services is offered as a free download from the Microsoft web site. However, the software only runs on a Microsoft NT 4 Server. One option might be to purchase the "Windows Media Training Server," system offered through a partnership Microsoft has with Compaq Computers. The system is priced under $4000.

While there is a version of the Windows Media Player that is available for use on the Macintosh platform, Microsoft has yet to make available authoring tools for the platform which would allow Macintosh users to create streaming content. (http://www.microsoft.com/windows/windowsmedia/en/default.asp)

Much of the information in section 5.5 can be found at the Streaming Media World Web site. **(**http://www.streamingmediaworld.com/gen/tutor/whatis/)

5.5 Multimedia Delivery

In presenting materials to distance-education students over the Internet, instructors will want to maximize the use of different media in order to have the best learning environment possible. The variety of media includes text, images, audio, and video. When these media are mixed in a single presentation, the combination is considered multimedia. Distributing and creating multimedia at this stage in technology is problematic. Listed below are two key issues to consider about multimedia presentations:

- Multimedia (especially, audio and video) presentations are large files, requiring high storage space and high bandwidth for delivery.

- The development of media technologies and applications has been unstructured and competitive, giving rise to low levels of compatibility and a multitude of components.

The solution to the first issue has been threefold: improved storage devices, creation of technology to offer higher bandwidths, and data-compression techniques. Some would argue that improvements in storage and the ability to offer higher bandwidth connections to home users at lower and lower costs has solved the problem of distributing multimedia; "however, with more and more users sending and receiving multimedia data, compression is still needed despite the increase in available bandwidths."[14] This section will take a closer look at compression technology.

The problem of Multimedia standards is complicated to resolve, because it demands the cooperation of technological developers in an often competitive environment. Several groups have formed to try to create standards for multimedia, including the International Multimedia Teleconferencing Consortium, Inc. (IMTC)[15], the Digital Audio Visual Council (DAVIC),[16] and the International Telecommunication Union (ITU).[17] Through such groups' efforts and through industry forces (i.e., Microsoft and Apple), integrative systems are being realized and certain standards are dominating. Major multimedia architectures will be further examined.

5.5.1 Compression Technology

In order to minimize the amount of storage space required for a complicated file, such as a video, compression is used. Compression works by eliminating redundancies in data. Compression can be done for any kind of file, including text, programs, images, audio, video, and virtual reality (VR). Compression can reduce the size of a file by a factor of 100 or more in some cases. For example, a 15-megabyte video might be reduced to 150 kilobytes. The uncompressed file would be far too large to download from the Web in a reasonable length of time, but the compressed file could usually be downloaded in a few seconds. For viewing, a decompression algorithm, which "undoes" the compression, would have to be used.

The term "codec" is an acronym that stands for compression/decompression. A codec is an algorithm, or specialized computer program, that reduces the number of bytes consumed by large files and programs.

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[14] Kuo, Franklin,Wolfgang Effelsberg and J.J. Garcia-Luna-Aceves eds. (1997). Multimedia Communications: Protocols and Applications. Upper Saddle River, NJ: Prentice Hall PTR. 9.
[15] The IMTC web site is http://www.imtc.org/index.htm
[16] The DAVIC web site is http://www.davic.org/
[17] The ITU web site is http://www.itu.int/

There are numerous standard codec schemes. Some are used mainly to minimize file-transfer time, and are employed on the Internet. Others are intended to maximize the data that can be stored in a given amount of disk space, or on a CD-ROM.[18]

5.5.2 Index of Codecs

Video Codecs:
Web Codecs
Sorenson Video - high-quality WWW video
RealVideo (Standard) - main video codec for RealVideo / RealMedia
H261 - low-quality videoconferencing
H263 (also known as I263) - medium-quality videoconferencing
MPEG-4 - high-quality WWW video
Photo-JPEG - photographic images
VDOLive - Server-based streaming video; scalable
CD-ROM/DVD-ROM/Kiosk/Presentation Codecs
Cinepak - medium-quality CD-ROM video, works on older computers
Sorenson Video - high-quality CD-ROM video; requires fast computer
Eidos Escape - high-quality CD-ROM video; requires high datarates
Indeo 3 - medium-quality CD-ROM video, works on older computers
Indeo Video 5.1 - high-quality CD-ROM video; requires fast computer
Apple Video - very fast, but low-quality (usually for testing)
MPEG-1 - high-quality CD-ROM video; requires special hardware or fast computer
MPEG-2 - high-quality DVD-ROM video; requires special hardware
Apple Animation - from HD, allows lossless fullscreen playback on very high-end systems
Hardware/Capture Codecs
Media 100 - codec allows files to be used without capture hardware
VideoVision Studio - codec allows files to be used without capture hardware
Avid Media Composer - codec allows files to be used without capture hardware
Truevision - codec allows files to be used without capture hardware
DV Camera - New format where digitizing is done in-camera
Apple Component Video - for capture on systems without JPEG hardware
Editing/Storage/Special-purpose Codecs
Motion-JPEG (MJPEG) - general-purpose video editing & storage
Apple Graphics - very similar to GIF; for images w/ limited colors
Apple None - lossless, but inefficient
Apple Animation - lossless storage
Photo-JPEG - used at 100% as a storage/transfer format, it creates significantly smaller files than animation.
Audio Codecs
IMA - 4:1 compression (usually for CD-ROM)
MPEG layer III audio- high-quality WWW music
QDesign Music Codec - high-quality WWW music at low datarates
Qualcomm PureVoice - speech at 14.4 modem datarates
G.723 - standards-based speech for videoconferencing
RealAudio - several inter-related codec for WWW audio[19]

[18] Whatis.com. (1999, October). Codec. [Online]. Available: http://www.whatis.com/ [1999, November 3].

5.5.3 Multimedia Architectures

Multimedia architectures include software components which provide for the creation, storage, and playback of media. They also define standard formats to store media and support codecs for audio and/or video.

Multimedia Architectures

QuickTime: QuickTime is Apple's multi-platform, industry-standard, multimedia software architecture. It is used by software developers, hardware manufacturers, and content creators to author and publish synchronized graphics, sound, video, text, music, VR, and 3D media. QuickTime 4 adds strong support for "real" (RTSP) streaming.
RealVideo (RealAudio, RealSystem G2): RealSystem G2 (the second generation of RealAudio and RealVideo) is exclusively focused on delivering media across the Internet. It supports both live and "on demand" video, and works with or without a dedicated server.
Microsoft Windows Media (NetShow), DirectShow/ActiveMovie, Video for Windows: Windows Media (formerly known as NetShow) is Microsoft's solution for delivery of Internet multimedia. The NetShow server supports both live and "on demand" video. Windows Media Player 4.0 for Windows is now available, and a (somewhat unstable) Macintosh version 3 is in beta. DirectShow (formerly known as ActiveMovie) is the successor to Microsoft's Video for Windows architecture. It is built on top of the DirectX architecture, and supports playback of multimedia from WWW, CD-ROM, and DVD-ROM. Video for Windows (also known as AVI) was primarily aimed at CD-ROM video (although it is also used on the WWW to some degree). It is no longer supported by Microsoft, and is being replaced by DirectShow/ActiveMovie.
MPEG: is a family of compression technologies, including MPEG-1, MPEG-2 and MPEG Layer III ("MP3")
Smacker: is a CD-ROM video architecture, which provides Cinepak-like quality. It is most popular with game developers, as it is optimized for low-to-midrange systems, and uses the 8-bit display mode popular with many action games.
VDOLive: is a streaming WWW video architecture produced by VDO.net, the makers of VDOPhone.
Emblaze: is a Java-based WWW video architecture, which is unique in that it does not require any plug-ins. However, proper playback does require the latest version of Java and a high-end computer, and even then generally falls short of other technologies. [20]

5.6 Courseware Packages

"Courseware" packages are Internet applications that integrate the multimedia information presentation (courseware), collaboration, and management tools of the Internet into a virtual or on-line distance learning environment.

Courseware packages make extensive use of the asynchronous (e-mail, file exchange, newsgroups) and synchronous (Chat, Whiteboard, Videoconferencing) collaborative tools available via the Internet. Almost all products now have enabled their software to be accessible via common Web browsers like Netscape Navigator and Microsoft Internet Explorer. The advantage of Web browsers as the interface for distributed learning environments

[19] Terran Interactive, Inc. 4/29/99. http://www.terran.com/CodecCentral/Codecs/index.html [accessed November 3, 1999].
[20] Terran Interactive, Inc. 4/29/99. http://www.terran.com/CodecCentral/Architectures/index.html [accessed November 3, 1999].

is that they are popular, easy-to-use, require no additional proprietary software on a user's computer and provide cross-platform access.

However, most packages are not multimedia development environments although some allow instructors with little or no HTML experience to be able to create Web pages. The media creation tools and authoring tools of the Web are necessary.

Before evaluating those commercial products, it is important to know about the range of possibilities available to university administrators today. An analysis was made of the evaluation of 37 commercial applications conducted by Dr. Bruce Landon of Douglas College, New Westminster, B.C. (see Section 5, Appendix C). Those rating criteria are grouped into learner tools (Web Browsing, Asynchronous Sharing, Synchronous Sharing, Student tools) and support tools (Course, Lesson, Data, Resource, Administration, Help desk). Each feature supported by specific application scores 1 for that application. The frequency (%) of companies with a certain feature gives an idea of the popularity or availability of that feature. 15 applications were ranked by summing up those scores. Among those applications, some were excluded because they are specifically designed for corporate training. There is also a deeper analysis of five products, which are widely used in universities and discussed in Distance Education Open Symposium.

By comparing the final 5 applications, it is obvious that most products lack synchronous sharing tools due to the limit of bandwidth on the Internet. As a result, the relatively less bandwidth intensive text-based chat became the most popular synchronous sharing tool (81 percents of 37 products provide it). Threaded discussion groups and e-mail are major collaboration tools. All productions emphasize the ease with which course content can be created by either providing templates or incorporating existing MS Word, PowerPoint, graphic files, and audio and video clips without prior knowledge of HTML. Both instructor and student (some products even allow administrator) do their tasks over the web. Most products provide support applications. Some are sold as components; some can be downloaded from their Web sites. Basic training and help are offered on their Web sites.

Inventory of Features

Learner Tools	**Available in % of 37 companies**					
Web Browsing		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Accessibility	22					1
Bookmarks	62		1	1	1	1
Multimedia	89	1	1	1	1	1
Security	84	1	1	1	1	1
		2	3	3	3	4
Asynchronous Sharing		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
E-mail	73	1	1	1	1	1
BBS_file_exchange	49	1	1		1	1
Newsgroups	62	1	1	1	1	1
		3	3	2	3	3
Synchronous Sharing		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Chat	81	1	1	1		1

Whiteboard	49	1		1		
Application_sharing	19			1		
Virtual space	16					
Group browsing	24			1		
Teleconferencing	41			1		
Videoconferencing	38			1		
		2	1	6	0	1
Student tools		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Self-assessing	54	1	1		1	1
Progress_tracking	54	1	1	1	1	1
Searching	30					
Motivation_building	43	1	1		1	1
Study_skill_building	32		1	1	1	
		3	4	2	4	3

Support Tools

Course		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Course_planning	49	1	1	1	1	1
Course_managing	65	1	1	1	1	1
Course_customizing	57	1	1	1	1	1
Course_monitoring	65	1	1	1	1	1
		4	4	4	4	4
Lesson		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Instructional_designing	57	1	1	1	1	
Presenting_information	51	1	1	1	1	
Testing	57	1	1	1	1	1
		3	3	3	3	1
Data		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Marking_on-line	57	1	1	1	1	
Managing_records	43	1	1	1	1	
Analyzing_and_tracking	46	1	1	1	1	
		3	3	3	3	0
Resource		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Curriculum_Managing	24	1				

Building_knowledge	30	1	1		1	
Team_Building	32	1	1		1	1
Building_motivation	22	1			1	
		4	2	0	3	1
Administration		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Installation	70	1	1	1	1	1
Authorization	51	1	1	1	1	1
Registering	51	1		1		1
On-line_fees_handling	19					
Server_security	51	1	1	1	1	1
Resource_monitoring	27		1	1	1	1
Remote_access	43	1	1	1	1	1
Crash_recovery	22	1	1			1
		6	6	6	5	7
Help desk		**Web Course in a Box**	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**Top Class**	**FirstClass**
Student_support	59	1	1	1	1	1
Instructor_support	62	1	1	1	1	1
		2	2	2	2	2
Raw Score of Features		32	31	31	30	26
Rank of top 15		5	6	6	10	12

Features and Technical Information Overview

	Web Course in a Box	**Asymetrix ToolBook**
Instructor features	Templates for courseware. Team-teaching ability.	Templates for courseware; Incorporate existing files; Drag-and-drop interface helps author courseware
Student features	Home page builder Personal portfolio and project builder	A vast range of highly interactive learning activities; Share knowledge with synchronized text and video
Administrator features	Ability to customize course listing page	Publish to internet or intranet or CD-ROM
System Requirements (Server)	RAM 64 MB; Disk Space:10 MB + 50K / course; WinNT 4.0; Unix Server	RAM 32 MB recommended; Disk Space 70 MB(up to 300MB for all optional components); WinNT 4.0; Unix Server: Solaris 2.4
Client Requirements	Netscape Navigator 3.0; MS IE 4.1	Netscape Navigator 4.06; MS IE 4.01

Pricing	$4,000 one time license, one year of technical support Suite, (Web Course in a Box, Web Campus in a Box, Web CourseBuilder ToolBox) for $6000	ToolBook II Assistant 6.5 : $1095, Librarian 6.1 : $3,000 per server and $50 per user ;Unlimited users: $50,000
Options	Web campus in a box and Web course builder enhance management and authoring of course.	Enhance management of learning activities with Asymetrix Librarian
Customers	Customers are available in appendix	

	Blackboard CourseInfo	**Top Class**	**FirstClass**
Instructor features	Courseware builder; Incorporate existing files.	Import existing course content using automated batch processing Reuse content in other course	Templates for courseware; Incorporate existing files; Drag-and-drop web publlishung
Student features	Bring together courses, groups and institutional information through a personalized environment	Course materials presented to an individual user can be modified on the fly based on test results	Client software integrating internet mail and web browser is recommended although not required
Administrator features	Administration over internet; Track and report faculty, student and courses statistics	Complete security over access to course content and tests	Communicate with existing E-mail system; Batch administration; High capacity servers; Administration over internet
System Requirements (Server)	RAM 256MB; Disk Space 4GB WinNT 4.0 with SQL Server 7.0; Unix Server with MySQL7.03.22	RAM 128MB WinNT 4.0; Mac OS; Solaris2.5.1; Red Hat Linux 5.2	RAM 4MB; Disk Space 10MB WinNT 4.0, Mac OS
System Requirements (Client)	standard web browsers	standard web browsers	4 MB RAM to use FirstClass client software
Pricing	$200-$35 per Course Site; Depends on package	50 users:$2,250 100 users:$3,750 200 users:$4,750	400 licenses for: one year renewable license $4,000; perpetual license (which means owning the latest software at the end of the year) $10,280; three year renewable / perpetual license: $10,120 / $13,240
Options	Enterprise edition can integrate with existing database and system	Work offline with TopClass Player Can be Integrated with synchronous sharing tools	Work offline with client software
Customers	Customers are available in Section 5, Appendix D		

Additional Notes

Web Course in a Box provides a variety of templates for course content and Quiz Builder and Whiteboard and Chat Facility.

Blackboard CourseInfo presents more personalized and customized functions for students such as managing online discussion: sort messages; collect messages in a printer friendly format; access direct links to user's courses web sites and groups.

Asymetrix ToolBook II Assistant provides more functions on synchronous sharing. Employing Dynamic Hypertext Markup Language (DHTML), Assistant lets one engage learners with a vast range of highly interactive learning activities, but also requires a higher client platform. Asymetrix Librarian running in combination with Web and database servers is designed to manage the complete process for delivering courses over the Internet.

TopClass has several support components that can be downloaded from their Web site. TopClass Player is "Web-based training without the Web" and is designed to work with TopClass plug-and-play courseware files that allow users who want to work offline or have very low bandwidth access to the TopClass Server to work on their course material offline. TopClass Assistants for Office 97 3.0 comprises 3 different utilities which are designed to make it easier to convert existing Word and PowerPoint files into TopClass courses (in the form of ".plug" files). This makes for rapid deployment of courses.

TopClass Analyzer extracts extensive usage information from the TopClass Server. TopClass Converter automatically converts existing training content into TopClass courses.

FirstClass Intranet Server Gold provides access over Internet, intranet, and LANs, and is compatible with existing systems and processes. Client software integrating Internet mail and Web browser is recommended, although not required, and can be downloaded from web site. For Windows, Lite to Full version: 1.4-3.7 MB; for Mac OS, 1.4-4.8 MB. Using Rapid Application Developer features to build application.

5.7 Web Server Technologies

The technologies involved in serving Web pages fall into two categories, hardware and software. Strangely, the term "server" is often used to describe both the server software and the machines that run this software, so a discussion of subject can often become somewhat confusing. To eliminate this confusion, discussions of server software and hardware will be categorized. However, there are a few comments that can be made about the purpose of server technologies in general.

Actually, there are a number of different uses for server technology in today's computing environments. A brief list of these would include network servers, application servers, printer servers, ftp servers and Web servers. In general, the main task of server technologies is to facilitate the exchange of information in a multi-user environment. For example, a printer server enables a number of different users to send documents to a shared printer. A Web server works under the same premise except instead of facilitating the exchange of information in a closed network environment a Web server responds to requests for information that arrive via the Web. These information requests can range from the simple display of a Web page created in HTML to, conceivably, a file download of any imaginable size, although most extremely large files, such as programs, are served via an FTP site.

The task of a Web server is to establish a connection with a user's browser in order to transfer the requested information as quickly as possible so the server may move on to the next request for information. Speed is critical, and often the machines that run server software employ several Central Processing Units (CPUs) to increase the speed with which the server may address simultaneous requests for information. However, most Web server software can operate on any desktop computer as long as there is enough memory to adequately run the server applications.

There is a large selection of server software available. Many of the best and most widely used server software packages are free, such as Apache. But there are also commercial products that offer competitive features and support software. The platforms or operating systems that most server software runs on typically fall into three categories: Unix, Windows NT, or Linux.

Web-server hardware is a bit harder to describe. The degree and complexity of the server hardware needed is proportionally related to the purposes for which the server will be employed. There are machines with multiple CPUs which help servers which receive large numbers of requests for information to perform adequately. A host who might need servers that employ multiple CPUs would be those with high-end computing environments or for those who wish to consolidate a number of servers onto one machine. However, a machine or rack of machines with a large number of CPUs would not necessarily be the most prudent choice for a Web host who expected only moderate amounts of traffic on its Web site. GSLIS would fall into this category because with use of password-protected class Web sites, only a few hundred users would be accessing the GSLIS Web site during a given day. Of course, the number of student users of the GSLIS Web site could go up if the popularity of Web-Based Education increases**.**

Web Server Software

There are a number of different Web-server software packages that are currently available. The following is a brief list of the most popular Web severs currently available.

Apache 1.3.9
The most popular Web server in existence today is the Apache Web server (newest version 1.3.9), which garners about 60% of the current Web-server market. Among Apache's most notable features are its cross-platform support, protocol support (HTTP/1.1), security, logging, and overall performance and robustness. Apache runs on Windows (95/98/NT), OS/2, and all the major variants of Unix. The server is fully compliant with HTTP/1.1 and supports API and ISAPI (NT). Apache distributes a core set of modules that handle everything from user authentication and cookies to typo correction in URLs. Above all, Apache 1.3.9 is available as a free download from the Apache Web site, and it is an open source project so Web administrators can conveniently configure the software to best meet their needs.

Microsoft Internet Information Server (MSIIS)
Coming in a distant second to Apache is the Microsoft Internet Information Server which garners about 23% of the current Web-server market. Beyond its core HTTP/1.1 services, MSIIS has a variety of tools including a Transaction Server (for building distributed applications), Index Server (indexing of HTML pages and MS Office documents), Certificate Server (managing digital certificates), Site Analyst (site management and usage), Internet Connection Services for Microsoft Remote Access Service (creation of Virtual Private Networks), Mail Server, and NNTP News Server. MSIIS runs only on the Window NT platform, but it has a mere $99 price tag.

Netscape Enterprise Server
Running an even more distant third is Netscape's Enterprise Server, which occupies about 6% of the current Web server market. Its services include Web publishing, access and version control, agent services, and link management. Also, Netshare facilitates group collaboration as multiple users may publish pages to the server; edit, share, or collaborate on creating a document; and control access to their documents, all without needing a system administrator to intervene.
It runs on HPUX 11.0, Solaris 2.6/7.0, and Windows NT 4. Its biggest drawback however, is its price, which ranges from $1295 for a Commercialware version to $995 for the Pro version.

Other free open-source Web servers include Jigsaw, TcI Web server, and Xitami.

Web Server Hardware

Giving a detailed description of the Web Server hardware currently available can be a somewhat daunting task. Web server software can run on a variety of machines ranging from a very average desktop computer to a much more robust multiprocessor unit. Accordingly, the prices for Web server hardware can be equally diverse, ranging from a couple of thousand dollars into the tens of thousands. Every major computer manufacture makes machines specifically designed to act as servers. Some even make specialty Web servers that come preloaded with specific platforms and server software.

Since GSLIS will probably only see a moderate amount of hits to its class Web sites on a given day there is no need for a more powerful multi-processor unit. Also, from interviews with current GSLIS staff it has been learned that GSLIS currently has the technology to begin serving a number of class Web pages immediately. We learned that these technologies are somewhat scalable and may serve the School's needs for some time to come. If, however, GSLIS chooses to consolidate its servers, a large multiprocessor unit may be an option.

Another important factor in serving a number of mission-critical Web pages is ensuring that the downtime in the event of a failure in technology is as minimal as possible. One method for doing this is by using a Redundant Array of Independent/Inexpensive Disks (RAID) subsystem in conjunction with the Web server. A RAID subsystem consists of a number of different disk drives that are "daisy chained" together and connected to the host system. Data are spread across the disks through what is called "striping" which involves partitioning each drive's storage space into units ranging from a sector (512 bytes) up to several megabytes. The stripes of all the disks are interleaved and addressed in order. Spreading data over the disk array ensures that if one disk fails, the contents of that disk can be automatically reconstructed from the contents of the other disks. Often, even with a failed disk the data in the RAID can still be accessed normally, and in some systems disks can be changed without turning the power off. Using a RAID subsystem can also dramatically increase the speed with which applications are served because all the disks are working at the same time. In this respect, a RAID subsystem is particularly useful to a Web server because it allows Web content to be delivered at a higher speed than the server would be able to accomplish on its own.

There are at least nine types of RAID plus a non-redundant array (RAID-0):

- RAID-0. This technique has striping but no redundancy of data. It offers the best performance but no fault-tolerance.
- RAID-1. This type is also known as *disk mirroring* and consists of at least two drives that duplicate the storage of data. There is no striping. Read performance is improved since either disk can be read at the same time. Write performance is the same as for single disk storage. RAID-1 provides the best performance and the best fault-tolerance in a multi-user system.
- RAID-2. This type uses striping across disks with some disks storing error checking and correcting (ECC) information. It has no advantage over RAID-3.
- RAID-3. This type uses striping and dedicates one drive to storing parity information. The embedded error checking (ECC) information is used to detect errors. Data recovery is accomplished by calculating the exclusive OR (XOR) of the information recorded on the other drives. Since an I/O (Input/Output) operation addresses all drives at the same time, RAID-3 cannot overlap I/O. For this reason, RAID-3 is best for single-user systems with long record applications.
- RAID-4. This type uses large stripes, which means you can read records from any single drive. This allows you to take advantage of overlapped I/O for read operations. Since all write operations have to update the parity drive, no I/O overlapping is possible. RAID-4 offers no advantage over RAID-5.
- RAID-5. This type includes a rotating parity array, thus addressing the write limitation in RAID-4. Thus, all read and write operations can be overlapped. RAID-5 stores parity information but not redundant data (but parity information can be used to reconstruct data). RAID-5 requires at least three and usually five disks for the array. It's best for multi-user systems in which performance is not critical or which do few write operations.
- RAID-6. This type is similar to RAID-5 but includes a second parity scheme that is distributed across different drives and thus offers extremely high fault- and drive-failure tolerance. There are few or no commercial examples currently.
- RAID-7. This type includes a real-time embedded operating system as a controller, caching via a high-speed bus, and other characteristics of a stand-alone computer. One vendor offers this system.
- RAID-10. This type offers an array of stripes in which each stripe is a RAID-1 array of drives. This offers higher performance than RAID-1 but at much higher cost.

- RAID-53. This type offers an array of stripes in which each stripe is a RAID-3 array of disks. This offers higher performance than RAID-3 but at much higher cost.[21]

Much of the technical information in this section was taken from Internet.com's Server Watch Web page[22]

5.8 The Question of Bandwidth

How to increase available bandwidth and how to have the optimal bandwidth?

Increased bandwidth, however, is not the only solution to faster Internet access. For example,

> A server that takes thirty seconds to respond at 28.8 Mbps will still take thirty seconds to respond even at T1/E1 speeds. That's because a faster link to an Internet service provider (ISP) speeds up only that portion of the system. The backbone, the routers, and the servers are not affected. They still impose their own barriers to ultra-fast communications. Only part of the problem has been addressed.[23]

5.8.1 Where does GSLIS Stand?

Many improvements are beyond the control of the client (potential distance education students) and the server (GSLIS). GSLIS is already in a good position to offer high throughput over the Internet.

> As part of the 1998-1999 Vision Plan, GSLIS joined the College of Education (COE) in purchasing a Fast Ethernet (100-base-T) switch, providing GSLIS with twelve available 100-base-T ports. Critical server machines have been upgraded with 100-base-compatible network cards and need only circuits of category 5 wiring to begin to harness this power for improved network services.[24]

This Fast Ethernet (100 Mbps) switch lies almost directly on UT's powerful network backbone. Given current technology, there is little that the school could do to improve upon the current situation.

5.8.2 Where do off-site students stand?

The network connections of the end users, distance-education students, present the real problems with maximizing bandwidth.

University students in dorms: Dorms and dorm rooms are connected to the university over ResNet. ResNet provides 10 Mbps Ethernet connections to dorm rooms and labs.

> The ResNet project was based on Ethernet switches, since these switches provide large amounts of bandwidth at a reasonable cost… The ResNet system provided one model for routing services in which high performance ports in Ethernet switches were grouped into VLANs, and routing services were provided to the VLANS from an external router using Cisco proprietary protocols. This system works quite well for the ResNet project, and is stable and reliable. However, this system is limited in the number of VLANs it can support and it requires

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[21] Whatis.com. (1999, October). RAID. [Online]. Available: http://www.whatis.com/ [1999, November 20].
[22] ServerWatch.com (1999,November). [Online] Available :Http://serverwatch.internet.com/webservers.html [1999, November 20].
[23] Eicon Technology Corp. (1998). Always On / Dynamic ISDN Addressing How We Really Want to Communicate, Economically. [Online] Available: http://www.isdnzone.com/info/default.asp [1999, October 23].
[24] GSLIS 1999-2000 Information technology Vision. (1999, February). [Online]. Available: http://www.gslis.utexas.edu/program/itvision.html#fast [1999, October 23].

> the purchase of expensive and port-limited high-end routers to provide layer 3 services. Therefore, this model is too limited and expensive to scale up to the number of ports required by all of the buildings on campus.[25]

University students in Austin area: Off-campus students who use ACITS's Telesys as their Internet Service Provider (ISP) are only offered V.90 International Telecommunication Union (ITU) modem standard, which supports a 56 Kpbs throughput. This deserves some explanation as to what exactly throughput of a 56K modem means. The delivery downstream speed from the ISP to the client never actually reaches 56Kbps for a multitude of reasons. The real issue is that the client side has only an upstream throughput of 33.6Kpbs. This discrepancy in throughputs from ISP-to-client and client-to-ISP is "fine for Web browsing… [b]ut an asymmetric protocol does not work well for functions like videoconferencing"[26].

The university has a newer ISP system called TeleSelect that offers ISDN capabilities, but for now this is only for faculty and staff access.

The trouble is that modem and ISDN BRI (Basic Rate Interface) network connections are not truly capable of handling even minimum videoconferencing (see Section 5, Appendix A). While ISDN through bonding is theoretically capable of reaching 128 Kbps, this maximum is unstable. Please see Internet Connections Section on ISDN.

The Greater Austin Area Telecommunications Network (GAATN) presents an interesting possibility for students to access high bandwidth.

> GAATN is a joint effort of the Austin Independent School District (AISD), Austin Community College (ACC), City of Austin, Lower Colorado River Authority (LCRA), Travis County, The State of Texas represented by the State General Services Commission, and The University of Texas at Austin that constructed a metropolitan-wide information super-highway… It is presently being used by participants for high-speed data networking. There are Token Ring, Ethernet, FDDI, Sonet and ATM connections between participants' sites. There is Internet data routing between entities at high speeds. Participants connect to the Internet over GAATN. It is also being used to provide for voice interconnections between participants' sites. Distance-learning classes for AISD, ACC and UT are presently provided on GAATN.[27]

Students who are unable to get high speed connections at their homes could be asked to go to and use the facilities of one of the agencies networked on the city-operated GAATN in order to do such things as video conferencing.

University students outside of Austin and Texas: These students will be responsible for getting a local ISP for home use.

5.8.3 The Present and Near Future High-Frequency Home Connections

DSL and cable modems present the best possibilities for low-cost, high-bandwidth connections for students. Fortunately, these two connection methods are now in competition for customers; thus they should become more widely available and drop in price.

> The toe-to-toe battle between technologies ultimately serves the consumer well. DSL prices have come down precipitously this year, now hovering around $50 per month, and new investments are pushing download speeds and the technological potential of systems upward.[28]

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[25] UTnet Evolution. (1996). ResNet Project, VLANs and VLSM. {online]. Available: http://www.ots.utexas.edu/utnet/utnet-evolve/utnet-evolve-30.html#HEADING30-0 [1999, October 23]

[26] Lu, Cary. (1998). The Race for Bandwidth: Understanding Data Transmission. Redmond, WA: Microsoft Press, p. 121.

[27] Greater Austin Area Telecommunications Network. (1999, June) [Online]. Available: http://www.gaatn.org/ [1999, October 23].

[28] Yahoo New. (1999, October). Bells Step Up Net Services to Compete with Cable. [Online]. Available: http://dailynews.yahoo.com/h/cn/19991020/tc/19991020003.html [1999, October 23].

5.8.4 Internet Bottlenecks

There are many problems that can occur once information is out on the Internet including latency, bouncing, and packet loss. There are some steps that GSLIS and off-site students can take to lessen these problems, but, for now, they are almost unavoidable.

5.8.5 Latency

GSLIS has some control over latency with its own routers and switches, but GSLIS cannot control latency problems over the Internet as a whole.

> One main component that causes lag is "ping," or network latency. A lot of people know that decent ping is anything under 300, good ping is anything under 120 or so, and excellent ping is 50 or less. But what do these numbers mean? Basically, these numbers are a measurement of how long it takes to send information from your computer to the server and back again, in milliseconds.[29]

Modem latency is an incurable ill.

> It turns out that modems have horrible latencies, somewhere around 100 milliseconds, 300 times worse than Ethernet latencies. Modems were designed for streams of data going between a terminal and mainframe, and thus they have built-in delays before they can start compressing and sending a block of data.[30]

For now, modems are almost the only way students access the Internet, and so modem latency will affect the quality of any streaming or synchronous course material.

5.8.6 Bouncing

While students and GSLIS can improve latency, bouncing is not something that can be controlled.

> Each bounce from one router to the next is called a "hop." Bear in mind that improving your connection only speeds up your data transfer rate from your home computer to your ISP's server. That's just one hop. There are still many hops that your data must take between the ISP's computer and the destination. Granted, the transfer rate and "ping" between your home computer and your ISP's server is usually the biggest bottleneck (using a modem adds 100ms overhead at least), but improving that transfer rate will not reduce your ping to all servers.
>
> If you're trying to connect from the USA to a server in Europe, you data will invariably estimate that each hop takes an average of 20 ms, then 20 hops x 20ms means that there's an overhead of 400ms latency that is unavoidable.[31]

5.8.7 Packet Loss

> Another major factor that determines lag is packet loss. To understand what packet loss is, we should first explain what packets are. Basically when your computer communicates with other computers, the data is not sent as a continuous, uninterrupted stream, like water out of a garden hose. Rather, data are sent in discrete "chunks" or packets, more like boxes along a conveyor belt. So if your computer is experiencing packet loss, it means that you're not receiving or delivering a steady stream of packets, analogous to boxes falling off the conveyor belt.

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[29] Colayco, Bob. (1999, April). Internet Connection Guide. [Online]. Available: http://www.firingsquad.com/guides/netconnect/page2.asp [1999, October 23].
[30] Lu, Cary. The Race for Bandwidth: Understanding Data Transmission. Redmond, WA Microsoft Press 1998, p. 160.
[31] Colayco, Bob. (1999, April). Internet Connection Guide. [Online]. Available: http://www.firingsquad.com/guides/netconnect/page3.asp [1999, October 23].

> It's easy to see why packet loss can play havoc with your [simultaneous conferencing] experience. Without a steady, reliable stream of data chunks, your computer is forced to "fill in the blanks," which can result in chop or skip in your frames. It is in fact possible for a person with higher ping (HPB) to experience smoother gameplay than someone with low ping (LPB), if the HPB has zero packet loss and the LPB has immense packet loss. Ping isn't everything.[32]

5.8.8 Internet Connections in Detail

5.8.8.1 Cable Modem

A cable modem is really more like a network interface card (NIC) than a computer modem. All of the cable modems attached to a cable TV company coaxial cable line communicate with a Cable Modem Termination System (CMTS) at the local cable TV company office. All cable modems can receive from and send signals to only the CMTS, but not to other cable modems on the line.

The actual bandwidth for Internet service over a cable TV line is up to 27 Mbps on the download path to the subscriber with about 2.5 Mbps of bandwidth for interactive responses in the other direction. However, since the local provider may not be connected to the Internet on a line faster than a T-1 at 1.5 Mpbs, a more likely data rate will be close to 1.5 Mpbs.

In addition to the faster data rate, an advantage of cable over telephone Internet access is that it is a continuous connection.[33]

Another interesting aspect of cable is that originally cable lines were laid down in rural areas that were unable to receive regular broadcasted television. With telephone companies being slow to introduce DSL technology (however, this could be changing very soon), especially in lower demand areas (rural areas for example), cable connections could be the answer to demanding all students have high-speed internet connections.

Cable modems have been criticized for having unacceptable latency problems[34] for real time applications.

5.8.8.2 Digital Subscriber Line (DSL)

DSL is a technology for bringing high-bandwidth information to homes and small businesses over ordinary copper telephone lines. xDSL refers to different variations of DSL, such as ADSL, HDSL, and RADSL. Assuming your home or small business is close enough to a telephone company central office that offers DSL service, you may soon be able to receive data at rates up to 6.1 megabits (millions of bits) per second (of a theoretical 8.448 megabits per second), enabling continuous transmission of motion video, audio, and even 3-D effects. More typically, individual connections will provide from 1.544 Mbps to 512 Kbps downstream and about 128 Kbps upstream. A DSL line can carry both data and voice signals, and the data part of the line is continuously connected. DSL installations began in 1998 and will continue at a greatly increased pace during 1999 in a number of communities in the U.S. and elsewhere. Compaq, Intel, and Microsoft working with telephone companies have developed a standard and easier-to-install form of ADSL called G.Lite that is expected to accelerate deployment. Within a few years, DSL is expected to replace ISDN in many areas and to compete with the cable modem in bringing multimedia and 3-D to homes and small businesses. Dataquest, a market research firm, forecasts 5.8 million lines installed by the end of the century.

How It Works

Traditional phone service (sometimes called "Plain Old Telephone Service" or POTS) connects your home or small business to a telephone company office over copper wires that are wound around each other and called twisted pair.

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[32] Colayco, Bob. (1999, April). Internet Connection Guide. [Online]. Available: http://www.firingsquad.com/guides/netconnect/page3.asp [1999, October 23].
[33] Ulrich, Johannes. (1999, October). *Whatis.Com*. Cable Modem. [Online]. Available: http://www.whatis.com/ [1999, October 23].
[34] Baughman, Jim. (1999, October). Austin Cable Modem Analysis [Online]. Available: http://home.austin.rr.com/throughput/Latency.html [1999, October 23].

Traditional phone service was created to let you exchange voice information with other phone users, and the type of signal used for this kind of transmission is called an analog signal. An input device such as a phone set takes an acoustic signal (which is a natural analog signal) and converts it into an electrical equivalent in terms of volume (signal amplitude) and pitch (frequency of wave change). Since the telephone company's signaling is already set up for this analog wave transmission, it's easier for it to use that as the way to get information back and forth between a client's telephone and the telephone company. That's why your computer has to have a modem – so that it can demodulate the analog signal and turn its values into the string of 0 and 1values that is called digital information.

Because analog transmission only uses a small portion of the available amount of information that could be transmitted over copper wires, the maximum amount of data that one can receive using ordinary modems is about 56 Kbps (thousands of bits per second). (With ISDN, which one might think of as a limited precursor to DSL, one can receive up to 128 Kbps.) The ability of one's computer to receive information is constrained by the fact that the telephone company filters information that arrives as digital data, puts it into analog form for one's telephone line, and requires a modem to change it back into digital. In other words, the analog transmission between one's home or business and the phone company is a bandwidth bottleneck.

Digital Subscriber Line is a technology that assumes digital data does not require change into analog form and back. Digital data is transmitted to your computer directly as digital data and this allows the phone company to use a much wider bandwidth for transmitting it to you. Meanwhile, if you choose, the signal can be separated so that some of the bandwidth is used to transmit an analog signal so that you can use your telephone and computer on the same line and at the same time.

Factors Affecting the Experienced Data Rate

DSL modems follow the data-rate multiples established by North American and European standards. In general, the maximum range for DSL without repeaters is 5.5 km (18,000 feet). As distance decreases toward the telephone company office, the data rate increases. Another factor is the gauge of the copper wire. The heavier 24 gauge wire carries the same data rate farther than 26 gauge wire. If you live beyond the 5.5 kilometer range, you may still be able to have DSL if your phone company has extended the local loop with optical fiber cable.[35]

5.8.8.3 Integrated Services Digital Network (ISDN)

ISDN is a set of CCITT/ITU standards for digital transmission over ordinary telephone copper wire as well as over other media. Home and business users who install ISDN adapters (in place of their modems) can see highly graphic Web pages arriving very quickly (up to 128 Kbps). ISDN requires adapters at both ends of the transmission, so your access provider also needs an ISDN adapter. ISDN is generally available from your phone company in most urban areas in the United States and Europe.

There are two levels of service: the Basic Rate Interface (BRI), intended for the home and small enterprise, and the Primary Rate Interface (PRI), for larger users. Both rates include a number of B (bearer) channels and a D (delta) channel. The B channels carry data, voice, and other services. The D channel carries control and signaling information.

The Basic Rate Interface consists of two 64 Kbps B channels and one 16 Kbps D channel. Thus, a Basic Rate user can have up to 128 Kbps service. The Primary Rate consists of 23 B channels and one 64 Kpbs D channel in the United States or 30 B channels and 1 D channel in Europe.

Integrated Services Digital Network (ISDN) in concept is the integration of both analog or voice data together with digital data over the same network. Although the ISDN you can install is integrating these on a medium designed for analog transmission, broadband ISDN (BISDN) will extend the integration of both services throughout the rest of the end-to-end path using fiber optic and radio media. Broadband ISDN will encompass frame-relay service for high-speed data that can be sent in large bursts, the Fiber Distributed-Data Interface (FDDI), and the Synchronous

[35] Whatis.com. (1999, October). DSL and xDSL. [Online]. Available: http://www.whatis.com/ [1999, October 23].

Optical Network (SONET). BISDN will support transmission from 2 Mbps up to much higher, but as yet unspecified, rates.[36]

5.9 Security and Authentication

In order to ensure that the Web-based courses are available to genuinely interested students, strong authentication schemes will have to be employed. One way of authentication is by maintaining a database of usernames and their passwords at GSLIS and validating user access based on these credentials. One of the strong means of authentication is by means of Digital Certificates which use the public/private key infrastructure for strong encrypted sessions.

In order to allow distant students to pay their fees online, a strong encrypted session has to be established for exchanging of confidential information like credit card numbers, Social Security numbers, personal data etc. This is possible by using the SSL (Secure Sockets Layer) functionality available with commercial Web browsers. A Webmaster developing a Web page can flag the page as requiring an SSL connection from all Web browsers. This allows online commerce to be conducted in a relatively secure manner.

Below are some of the recommended authentication methods and an introduction to the encryption technology which can be used for Web-based education.

5.9.1 Encryption Technologies

Symmetrical Encryption:
In this type of encryption, a message is encrypted with a key. This message can not be decrypted without this key. Symmetrical encryption gets its name from the fact that the same key is used to encrypt and decrypt the files. It offers the highest level of encryption, but it has one big disadvantage. E-mail must be used to deliver the key to its user. If somebody intercepts the key enroute, security is compromised.

Public-Key Encryption:
With this, it is not necessary to communicate the key to the recipient of the message. Unlike symmetrical encryption, which uses one key, public key encryption uses two keys, an encryption key and a decryption key. A user begins with an encryption key, which is made publicly available. This key is used to encrypt anything that's being sent to someone, such as an e-mail message. While enroute, nobody can read the encrypted message. Furthermore, the encrypted message cannot be decrypted using the encryption key. To read the message, the decryption key is required. This is private; only the user has it. By applying the decryption key to the message encrypted with user's own encryption key, the message can be decoded and read.

To use secure e-mail, you need a public key encryption program that can generate a key pair for you. This pair consists of your public key, which you send to others, and a private key which you keep on your computer. Once the key pair has been generated, you can exchange secure-mail with someone who has also generated a key pair. To send mail to this person, you need that person's public key. You use the public key to encrypt the message, and she decrypts it using her private key. When she sends a message to you, she encrypts it using your public key and you decode it using your private key.

Authentication:
An Authentication problem is in basic terms not knowing whether somebody's public key is really that person's key or a fake. To solve this problem, we use DIGITAL SIGNATURES.A digital signature is an encrypted version of the e-mail message's header and text. The signature is encrypted using the sender's private key. This signature can be decoded using the sender's public key. Since the message cannot be properly decoded if it has been altered enroute, or encoded with anyone else's key, proper decryption means that the message came from the person who ostensibly sent it.

[36] Whatis.com. (1999, October). ISDN. [Online]. Available: http://www.whatis.com/ [1999, October 23].

What a public key encryption software must do:

1.Generate a key pair.
2.Distribute your public key to others
3.Receive other's public keys
4.Create a digital signature for your outgoing messages.
5.Decrypt the digital signatures of incoming messages to make sure they are valid.
6.Encrypt an outgoing message with someone else's public key.
7.Decrypt an incoming message with your own private key.

BEST PACKAGE AVAILABLE: DOS Package called PGP (Pretty Good Privacy)

5.9.2 Examples of some Web/Network authentication schemes:

Security Tokens
Security tokens, also called token cards, are password generating devices that can be used to access local clients or network services. Physically a token is a small device with an LCD display that shows the current password and the amount of time left before the password expires. Once the current password expires, a new one is generated. This provides a high level of authentication security, as a compromised password has a very limited life span. Security tokens are not authenticated directly by the operating system or application logged onto. An agent is required in order to redirect the logon request to an authentication server. Each security token is identified by a unit ID number. This ID number uniquely identifies each token to the server. It is also used to modify the algorithm used to generate each password, so that multiple tokens will not produce the same sequence of passwords. Since passwords expire at regular intervals, usually 60 seconds, the security tokens need to be initially synchronized with the server. One advantage of this scheme is that, even if the user does read off his password to another user, the consequences are minimized because the password is only valid for a very short period of time. A number of these tokens are produced by Security Dynamics Technologies and known as SecurID cards.

KERBEROS:
Kerberos is an authentication solution that is designed to provide a single sign-on to a heterogenous environment. Kerberos allows mutual authentication and encrypted communication between users and services. Unlike security tokens, however, Kerberos relies on each user to remember and maintain a unique password. When a user authenticates to the local operating system, a local agent sends an authentication request to the Kerberos server. The server responds by sending the encrypted credentials for the user attempting to authenticate to the system. The local agent then tries to decrypt the credentials using the user-supplied password. If the correct password has been supplied, the user is validated and given authentication tickets, which allows the user to access other Kerberos-authenticated services. The user is also given a set of cipher keys that can be used to encrypt all data sessions.

Once the user is validated, he is not required to authenticate with any Kerberos-aware servers or applications. The tickets issued by the Kerberos server provide the credentials required to access additional network resources. This means that while the user is still required to remember her password, she only needs one password to access all systems on the network to which she has been granted access.

One of the biggest benefits of Kerberos is that it is freely available. The source code can be downloaded and used without cost. There are also many commercial applications, such as IBM's Global Sign-On (GSO) product, which are Kerberos-compatible but sport additional features and improved management. A number of security flaws have been discovered in Kerberos over the years, but most, if not all, have been fixed as of Kerberos 5.

Secure Sockets Layer (SSL)
Created by Netscape, SSL provides RSA encryption at the session layer of the OSI model. By encrypting at the session layer, SSL has the ability to be service-independent. Although SSL works equally well with FTP, HTTP, and even Telnet, the main use of SSL is in secure Web commerce. Since the RSA encryption is a public-private key

encryption, digital certificates are also supported. This allows SSL to authenticate the server and optionally authenticate the client.

Netscape includes SSL in its Web browser and Web server products. Netscape has even provided the source code so that SSL can be adapted to other Web-server platforms. A Webmaster developing a Web page can flag the page as requiring an SSL connection from all Web browsers. This allows online commerce to be conducted in a relatively secure manner.

Currently very few operating systems embed all these schemes, but NT 5.0 will have security improvements like direct support for the Kerberos authentication system, public-encryption key-certificate services, IPSEC support, and support for smart cards.

5.9.3 Future Trends in Security and Authentication

There have been a number of advances in network security in recent years with the proliferation of computer networks throughout the business world. New techniques are being developed to deal with security and authentication issues in ways that will eliminate the security breaches caused by borrowed or stolen passwords. One such technique is called biometrics, which seeks to incorporate the physical features of the user into the authentication process.

There are two major types of biometric products: those that measure behaviors, such as handwriting and voice characteristics, and those that measure one aspect or another of an individual's physiology. Among the physiological biometric tools are retinal and iris scanners, thermal scanners, voice prints, and face-recognition systems.

Common Biometric techniques and how they rate:

	USER CRITERIA		**SYSTEM CRITERIA**	
	INTRUSIVNESS	**EFFORT**	**ACCURACY**	**COST**
Dynamic signature verification	Excellent	Fair	Fair	Excellent
Face geometry	Good	Good	Fair	Good
Finger scan	Fair	Good	Good	Good
Hand geometry	Fair	Good	Fair	Fair
Passive iris scan	Poor	Excellent	Excellent	Poor
Voice print	Very Good	Poor	Fair	Very Good
Retina scan	Poor	Poor	Very Good	Fair

Source: International Biometric Group, New York

The following ins a brief list of some current biometric products put together by Federal Computer Week (http://www.fcw.com/pubs/fcw/1999/1122/fcw-mktbio-11-22-99.html)

A Comdex Biometrics Sampler

BioPassword LogOn for Windows NT, Net Nanny Software International Inc. Uses "keystroke dynamics" -- the unique rhythm with which individuals type -- to identify a user.

FaceIt, Visionics Corp. Maps the image of a face to a mathematical formula that can be matched and compared to others.

Fingerprint Recognition System, SecuGen Corp. Manufacturers have integrated this technology into devices that include a mouse, an automated teller machine, a door lock, a time- and attendance-management system, and a keyboard.

IrisAccess and PC Iris, IriScan Inc. Uses a video camera to capture the iris's unique patterns.

Positive Identification System, NEC Technologies Inc. Uses a fingerprint scanner and client software to authenticate users.

SaftyLatch, Saflink Corp. Uses voice recognition to encrypt folders and files.

SmartPen, LCI Technology Group N.V. Uses sensors inside a ballpoint pen to measure the angle, force and acceleration of a person's signature.

Veriprox, Biometric Identification Inc. Combines fingerprint identification with a card reader. The fingerprint of the person seeking entry must match the identity of the card holder.

5.10 The Current State of WBE Technologies

The following discussion is based upon a survey posted on the Distance Education Online Symposium (DEOS) listserv and upon information from various university Web sites. For purposes of emphasis upon WBE in LIS, the majority of the schools discussed below are LIS schools. In addition to this, two schools not directly related to LIS are discussed, because of their high achievement in distance education. These schools are Penn State and Capella University.

As a WBE provider, a school must make a choice in the types of technologies to be used for course delivery. Some schools have highly effective results simply from utilizing simple tools such as email and discussion boards. However, with the increase in the offering of full programs by WBE, schools must decide whether to use a commercial Web-course software product or to develop a software package tailored to their own specific needs.

5.10.1 In-house Development of Web Course Packages

At the University of Illinois GSLIS department, LEEP (Library Experimental Educational Program) is a distance-education option offered to students. The program also uses in-house designed software for their distance-education courses. According to Linda C. Smith, none of the current commercial packages are suited for an online degree program, but rather they are designed for individual courses. The software is developed by the technology staff. A similar example of this has occurred at the College of Information Studies at Florida State University, which utilizes what the coordinators describe as a "homegrown" Web template, called WebMC.

Many schools choose to use commercial software for some courses, while developing in-house software for other selected courses. Pennsylvania State University uses this method. According to Allan S. Gyorke, some of the classes do not require as much technology, and therefore are designed by the technology team. Undoubtedly this saves the department money and by opting for varying packages to fulfill the technology needs of the department.

Capella University also uses commercial software, but often must supplement it with its in-house systems. According to Bruce Francis, this is due to the fact that their software choice, Lotus Learning Space, did not have sufficient registration and student tracking systems at the time.

5.10.2 Commercial Software Packages

The most common software packages are used by schools for the purpose of enabling online class discussions, such as WebCT. The University of Arizona School of Information Resources and Library Science uses WebCT as a supplement to its online courses, primarily for online class discussions. In addition to WebCT, the University of South Florida School of Library and Information Science uses CourseInfo. Penn State University uses WebCT, but also uses FirstClass Intranet Server. More information regarding universities' choices of commercial packages is available in the section on Courseware Packages (5.7).

Some schools buy commercial web packages and then modify these packages to fit specific needs of the program. An example of this is practiced at Cappella University. Bruce Francis, an administrator at Cappella University, reported that it is necessary to modify the user interface of their Lotus Learning Space software so that it is identified more with the Cappella University identity.

5.10.3 Additional and Supplemental Technologies

In addition to course packages, schools involved in WB distance education are striving to utilize other technologies in order to supplement Web courses. Examples of these are asynchronous communication technologies as simple as email listservs, but they also include tools such as whiteboards and bulletin boards. Asynchronous learning tools are also prevalent, such as online slide transmission. More difficult technologies being embraced are the multimedia types such as streaming video and compressed video. Undoubtedly educators recognize the need for multimedia in enhancing course effectiveness. Some of these tools are already incorporated into various Web course packages. However, many schools still find it necessary to use these supplemental technologies, because their commercial package is often insufficient as a "stand-alone" system.

5.10.4 Current Technological Student Requirements for WB Distance Education

In order to function in a WB distance-education environment, students often must meet certain technological requirements. These requirements involve a student's individual knowledge of computers as well as the specific software and hardware that the student must have access to in order to participate in the course. The GSLIS program at the University of Illinois requires students to have basic computer skills, such as starting programs or finding and saving files in a directory. Knowledge of the Internet is required in order to connect via telnet or the Web as well as for the purposes of searching online databases. In addition to this, proficiency with email and bulletin boards and knowledge of online etiquette is stressed.

The table below represents typical **minimum** hardware requirements by some of the GSLIS schools discussed, in addition to the two non-GSLIS schools. Many of these schools also require software.

	CPU	**RAM**	**OS**	**Hard Drive**	**Modem**	**CD-ROM**	**Sound/ Video Cards**	**Monitor**
LEEP	Pentium	16 MB	W 95 or Mac 7.53	500 MB free	28.8 speed	yes	With speaker and earphones	Color with 640x480 resolution
FSU	233 MHz or 333 MHz (iMac)	32 MB	W 95/98 or MAC OS 8/5	6 GB	56 kbps V .90	16x speed	Factory installed sound card. Video-2MB RAM	14" SVGA or 15" multiscan (MAC)
U of AZ	486 PC or Mac equivalen t				28.8			

U of S. FL.	486/66 IBM or PowerMac	16 MB			28.8			
Syracuse	100 MHz or Mac equivalent	16 MB		1 GB	28.8	yes	With speakers and micro.	Color and 800x600 resolution
Penn State	100 MHz	32 MB	W 95/98/NT Or Mac 8.1	100 MB free	28.8			14" and 800x600 resolution

5.10.5 Future Vision of Schools

A common goal for many schools *already involved* in WB distance education is the gradual increase in courses offered on the Web over the course of the next few years. Such an increase greatly affects the traditional aspects of education, from testing procedures, to the staff and support team necessary in order to translate a curriculum to Web delivery. Many schools are moving away from traditional testing and focusing more on evaluation through projects. In addition to this, distance-education professionals realize the need for continual development of Web course design. For many schools, there are design problems that need to be solved through experimentation and experience. The technological possibilities offered by streaming audio and video are being investigated by schools; however, there are currently limitations to these technologies, as discussed in the bandwidth section.

5.11 GSLIS Technology Assessment

Currently GSLIS has a variety of technologies in place that could be used for future WBE projects. The purpose of this section is to give a brief overview of these. Not all the computer hardware and software that GSLIS owns will be discussed, only that involved with the creation and delivery of Web-based content. These technologies will be broken down into the two categories, Web-based content creation and publishing tools and Web-server hardware and software.

One of the most important factors that affect the delivery of Web content is the connection speed with which GSLIS servers are able to connect to the Internet. As mentioned earlier in this document, GSLIS recently joined the College of Education (COE) in purchasing a Fast Ethernet (100-base-T) switch, providing GSLIS with twelve available 100-base-T ports. These ports should enable GSLIS to begin serving dynamic multimedia-based class Web pages immediately. For a more detailed discussion of bandwidth and its importance to WBE, please see the section of this document entitled “The Question of Bandwidth.”

5.11.1 Web content creation and publishing tools

Web content creation tools may range from simple HTML editors to highly complex animation, video, and image editing software. GSLIS currently owns versions of several software packages considered industry standards for the creation and editing of Web content, including Adobe’s Photoshop, Illustrator and Premier and Macromedia’s Dreamweaver, Director, and Flash. The following chart lists the software GSLIS currently owns that can be used for the creation or editing of Web-based content. The chart was prepared from information on the GSLIS Web page and from interviews with GSLIS staff. Those items marked with a * have been discussed in earlier portions of this document.

Software Creator	Title	Version
Adaptec	Adaptec Toast	3.5.4
Adobe	Acrobat	4.0
Adobe	Illustrator*	8.0
Adobe	Pagemaker	6.52
Adobe	Photoshop*	5.0
Adobe	Premier	5.0
Adobe	After Effects	
Avid	Cinema	1.0
Bare Bones	BB editlite	4.0
Dartmouth	FTP Fetch	3.0.3
Macromedia	Aftershock*	2.0
Macromedia	Director*	6,6.5
Macromedia	Dreamweaver*	2
Macromedia	Extreme 3D	2
Macromedia	Fireworks	2
Macromedia	Flash	4
Macromedia	Soundedit	162
Macromedia	xRes	3
Realnetworks	RealProducer*	G2

The machines that run the above software are for the most part located the GSLIS Multimedia Lab. A look at the hardware the Multimedia Lab currently has will provide an indication what is needed to adequately support such software. Also listed is other hardware that could be specifically used in the creation or editing of Web based content.

Hardware the Multimedia Lab currently has available:

- 2 G3 Upgrade PowerMacs
- 2 Blue & White G3 PowerMacs
- 1 PowerMac G3
- 1 PowerMac 8500/120
- 1 Hewlett Packard Scanjet 6100C flatbed scanner
- 1 Nikon Coolscan 2 slide scanner
- 1 USB Avid Cinema
- 1 SCSI CD Rewritable burner
- 1 Kodak Digital Camera
- 1 Cannon Digital Camera
- 1 Toshiba Digital Camera
- SVHS Video Camera

5.11.2 Server Hardware and Software

According to GSLIS staff there are three machines that handle all primary Internet applications. That is, "there are three Web servers currently in use by GSLIS.The primary Internet servers consist of two Sun Ultra Sparc 1 Workstations (lexus and fiat). Each of these runs the Solaris Operating System (v. 2.5.1). Fiat runs the Apache Web server as GSLIS's primary web service. Lexus acts as the login machine for studentds. staff, and faculty to access Internet services, including Web pages, e-mail, etc. In addition, and probably particularly important for WBE, lexus runs a version of the Real Server (a free 25-seat, simultaneous streams server)."

In addition to fiat and lexus, GSLIS maintains a Dell Optiplex with SCSI Hard Disks running a version of RedHat Linux. Named cobra, this server also runs a version of RealServer with up to 25 simultaneous connections which has been used as the primary means of
delivering streaming media content to the LIS 312 Online classes.

All three of these machines are connected to the Internet via dedicated 100 Mb/s lines, which provides more than enough bandwidth for current usage, and gives GSLIS's network traffic significant room to grow.

GSLIS Web servers in detail

lexus

Type of machine:	Sun Ultra Enterprise 1 Workstation, local 2G hard drive and processor speeds of 143 Mhz wit 256Mb of RAM.
Software:	Solaris Operating System (v. 2.5.1), RealServer from Real Networks
Duties:	login machine for students, staff and faculty to access their internet services including web pages, email, etc.

Fiat

Type of machine:	Sun Ultra Enterprise 1 Workstation, local 2G hard drive and processor speeds of 143 Mhz wit 256Mb of RAM. Fiat also has an attached disk array (RAID 5) which contains about 45G of space.
Software:	Solaris Operating System (v. 2.5.1), Apache web server (GSLIS's primary web service).
Duties:	GSLIS's primary web service.

Cobra

Type of machine:	Dell Optiplex with a Pentium II 333 processor, 128M of RAM, and about 8G of hard drive space split between two drives.
Software:	RedHat Linux, RealServer with up to 25 simultaneous connections
Duties:	Delivering streaming media content to the LIS 312 Online classes.

5.11.3 Current GSLIS IT Staff

Currently GSLIS employs three full time staff members in conjunction GSLIS IT services.

- **Systems Analyst/Systems Administrator**
  Function: Install, evaluate, and upgrade server software to support School Internet and intranet services. System maintenance as well as writing custom software to support the School's use of the Internet and intranet services.

- **Computer Systems Development Specialist**
  Function: Supportsstudents, faculty, and staff in computer and Internet use. Maintain, upgrade, and troubleshoot computer equipment and software. Assist in hiring and managing IT Lab staff.

- **Information Analyst**
  Function: To provide communication, organization, and technical skills in the development of Web-based course information systems.

In addition GSLIS also hires a group of TA's each semester who are responsible for much of the day-to-day activities related to the GSLIS IT and Media Labs. These duties are shared and include the following: set up of classroom demonstration hardware for faculty, assisting student , faculty and staff users of the IT and Media Labs, routine machine maintenance, and development and offering of short courses in the area of information technology.

5.12 Technology Recommendations

The following recommendations fall into three categories: GSLIS technology, GSLIS Web-based education technical staff recommendations, and student requirements.

5.12.1 GSLIS Technology

First, it must be noted that none of the Web-based technologies contained in this report were tested by the writers. Testing and evaluation is the most important aspect of choosing the appropriate technologies to be used in the GSLIS Web-based Distance Education program. So, our first recommendation is that GSLIS thoroughly test any technologies to be used in for the purpose of Web-based education before a significant investment in technology is made by the School. To accomplish this we recommend that GSLIS initially use software that is free for the School, such as WebCT, for the first round of Web-based courses. Generally, freeware and shareware offer many of the same features as full software packages, and most often a vendor will provide a shareware copy of its product for testing and evaluation purposes if there is a possibility that a client will purchase an extensive user license. This is a less expensive way to experiment with products to discover which technologies are most compatible with the goals of the GSLIS Web based education program before making a significant investment.

5.12.1.1 Courseware Packages

We do not recommend the use of any one courseware package. In fact, we are not convinced that the functions found in most courseware packages can not be duplicated in-house by GSLIS staff through the combination of free software and Web-authoring techniques. LIS 312 is an example of successful Web-based class that employs many of the features found in most courseware packages.

The courseware package that we had the most exposure to was WebCT. This is because the University of Texas currently has an unlimited user license for WebCT, which allowed our class to use the package throughout the Fall 1999 semester. Actually, WebCT proved to be quite adequate for many asynchronous communication purposes. However, many students in our class experienced frustration with various aspects of the software, requiring several tutorials in order understand relatively simple tasks. It must be said, however, that WebCT was not used as the primary medium for student and teacher interaction by our class. In this respect, our class's use of WebCT should not be considered as a true test if the software's potential as a fully functioning course package.

For these reasons we cannot absolutely endorse the use of WebCT by GSLIS for Web based distance education. However, we do recommend, since the software's use is free, that GSLIS test WebCT in a section of LIS 312 to determine if the software functions adequately as a communication medium for a course that is taught completely online.

5.12.1.2 Web Content Delivery

The major problem with the delivery of Web-based content is the connection speed of current dial up modems. For instance, a student using TeleSys, UT's dial-up service, could not conveniently receive the RealVideo content that is currently a major component of LIS 312.

In light of such bandwidth restrictions we recommend that synchronous communication in Web-based courses be kept to a minimum until faster connections speeds become the standard. To perform adequately, synchronous communication methods such as audio or video conferencing require that a student user have a high-bandwidth connection. Also, some asynchronous communication techniques, such as stand-alone video or animation files, demand a high-bandwidth connection to avoid slow download speeds that might diminish the effectiveness of course modules that employ such techniques. Streaming media will not completely eliminate such delays and its use should not be considered an adequate remedy for students that connect to the Internet at a lower bandwidth.

Furthermore, although faster connection speeds provided by cable modems, ISDN, and DSL are becoming widely available, we do not believe that at this time GSLIS can reasonably expect students to invest in such technology in order to take online classes. There are several reason for this recommendation. First, the University of Texas does not provide anything other than a dial-up connection for local Austin area students. It does not seem reasonable to

require a technology that students can not even receive from UT's own Internet service. Also, requiring high-bandwidth connections such as DSL or cable may exclude prospective students from rural areas where these services are not available.

To remedy this problem we recommend that GSLIS offer students who do not have a high-bandwidth connection a CD containing all of the dynamic media that a Web-based course may employ. For example, the CD would contain video, animation, or audio files that would normally cause unmanageably slow download speeds with a dial-up connection. This would allow students who connect to the Internet at slower speeds to receive all course content without diminishing the quality of course modules. These CDs could be easily created using technology that GSLIS currently owns.

While we do not recommend that GSLIS *require* high-bandwidth connections of their Web-based distance-education students, we do believe that GSLIS should *recommend* that students acquire a high-bandwidth connection if at all possible.

5.12.1.3 Web Authoring

GSLIS currently owns industry-standard Web Authoring, Image Authoring, Video editing and Audio editing software. We do not have any recommendations for the purchase of any software that GSLIS doesn't already own.

5.12.1.4 Hardware

From interviews with current GSLIS IT staff it was learned that the School currently has the hardware(i.e servers) to begin servicing a number of additional class Web pages. If, however, additional purchases are required in the future, we recommend that these technologies be scalable to allow for additional growth.

While GSLIS currently owns several multimedia workstations that could be used for the creation of class Web pages, we recommend that the School purchase additional machines that would be devoted solely to the creation of class Web pages. These should be higher-end workstations with the appropriate processor speeds and memory for the use of graphic and video editing applications.

5.12.2 GSLIS Web Staff

To produce quality courses, it is recommended that the GSLIS hire additional full-time staff whose sole responsibilities will be the creation and maintenance of class Web pages.

- First, we recommend the hiring of a Web Developer/Administrator, who would act as a coordinator and expert resource throughout the creation process.
- Second, we recommend the hiring of a Multimedia Developer, who would be responsible for the creation of course modules that employ the extensive use of graphics, video, or audio.
- Third, an Instructional Designer should be hired who would work with instructors and Web designers to ensure the creation of adequate course modules that reflect the wishes of the instructor and the needs of the students in a Web-based environment.
- Last, we recommend that a Network Administrator be hired to manage the GSLIS Web servers in order to ensure that mission-critical applications remain up and running.
- Additionally, the IT Lab staff can offer supplementary support, but the Web-based courses should not detract from their current duties. Student support should also be sought either from within the GSLIS or from other academic units such as the College of Communication.

Also, some software, such as Macromedia Director and Adobe Photoshop, demands a professional developer. Should the School choose to use such software,then additional staff may be required.

5.12.3 Student Requirements

It is recommended that GSLIS demand the following technical requirements from Web-based distance-education students.

Processor speed:	233mhz or better
Memory:	32mb or better
Monitor:	Color, 800 x 600 resolution
Browser:	Internet Explorer or Netscape compatible(with appropriate plugins)
Modem:	28.8 Kbps or better (DSL or Cable recommended)
OS:	Win 95/98/NT or Mac OS 8.1
CDrom	Yes
Video Card	Yes
Sound Card	Yes
Speakers/Headphones	Yes

If classes require Video Conferencing capabilities a desktop video camera should also be required of students.

Section 5 Appendix A

Slow Data Types[37]

Data Type	**Required Bandwidth**
RealAudio (poor sound)	14.4 Kbps stream
Minimal Web browsing	28.8 Kbps burst
Voice circuit (POTS)	64 Kbps
Minimal videoconferencing	96 Kbps

Slow Connections

Connection Type	**Bandwidth Provided**
Analog Modem	33.6 Kbps
"56K" modem	45-56 Kbps
ISDN-1B (single circuit)	64 Kbps
ISDN-2B (dual circuit)	128 Kbps

Fast Data Types

Data Type	**Required Bandwidth**
Quarter-screen video (good stereo sound)	384 Kbps
CD audio (poor full-screen video)	1.2 Mbps
NTSC (poor video)	2-3 Mbps
NTSC (decent video)	6 Mbps
High-definition TV (compressed)	19 Mbps
Broadcast TV	23 Mbps
High-definition TV (uncompressed)	1.2 Gpbs

[37] Lu, Cary. (1998). The Race for Bandwidth: Understanding Data Transmission. Redmond, WA: Microsoft Press, 151-153

Section 5 Appendix B

Data Connection Speeds

Carrier Technology	Speed	Physical Medium	Application
Regular telephone service (POTS)	Up to 56 Kbps	Twisted-pair	Home and small business access
Dedicated 56 Kbps on Frame Relay	56 Kbps	Various	Business e-mail with fairly large file attachments
DSO	64 Kbps	All	The base signal channel in the set of Digital Signal levels
ISDN	BRI: 64 Kbps to 128 Kbps PRI: 23 (T-1) or 30 (E1) assignable 64 Kbps channels plus control channel; up to 1.544 Mbps (T-1) or 2.048 (E1)	BRI: Twisted-pair PRI: T-1 or E1 line	BRI: Faster home and small business access PRI: Medium and large enterprise access
IDSL	128 Kbps	Twisted-pair	Faster home and small business access.
Satellite	400 Kbps (DirecPC)	RF in space (wireless)	Faster home and small enterprise access
Frame Relay	56 Kbps to 1.544 Mbps	Twisted-pair or coaxial cable	Large company backbone for LANs to ISP ISP to Internet infrastructure
DS1/T-1	1.544 Mbps	Twisted-pair, coaxial cable, or optical fiber	Larger company ISP ISP to Internet infrastructure
E-1	2.048 Mbps	Twisted-pair, coaxial cable, or optical fiber	Large company to ISP ISP to Internet infrastructure
T-1C (DS1C)	3.152 Mbps	Twisted-pair, coaxial cable, or optical fiber	Large company to ISP ISP to Internet infrastructure
DS2/T-2	6.312 Mbps	Twisted-pair, coaxial cable, or optical fiber	Large company to ISP ISP to Internet infrastructure
Digital Subscriber Line (DSL)	512 Kbps to 8 Mbps	Twisted-pair (used as a digital, broadband	Home, small business, and enterprise access using existing copper

		medium)	lines
E-2	8.448	Twisted-pair, coaxial cable, or optical fiber	Carries four multiplexed E-1 signals
Cable Modem	512 Kbps to 52 Mbps (See Key and index)	Coaxial cable (usually uses Ethernet); in some systems, telephone used for upstream requests	Home. Business, school access
Ethernet	10 Mbps	10BASE-T (twisted-pair); 10BASE-2 or -5 (coaxial cable); 10 BASE-F (optical fiber)	Most popular business local area network (LAN)
E-3	34.368 Mbps	Twisted-pair or optical fiber	Carries 16 E-1 signals
DS3/T-3	44.736 Mbps	Coaxial cable	ISP to Internet infrastructure Smaller links within Internet infrastructure
OC-1	51.84 Mbps	Optical fiber	ISP to Internet infrastructure Smaller links within Internet infrastructure
HSSI	Up to 53 Mbps	HSSI cable	Between router hardware and WAN lines Short-range (50 feet) interconnection between slower LAN devices and faster WAN
Faster Ethernet	100 Mbps	100BASE-T-4 (twisted pair); 100BASE-TX (twisted pair); 100BASE-FX (optical fiber)	Workstations with 10 Mbps Ethernet cards can plug into Fast Ethernet LAN
FDDI	100 Mbps	Optical fiber	Large, wide-range LAN usually in a large company or a larger ISP
T-3D (DS3D)	135 Mbps	Optical fiber	ISP to Internet

			infrastructure Smaller links within Internet infrastructure
E-4	139.264 Mbps	Optical fiber	Carries 4 E3 channels. Up to 1,920 simultaneous voice conversations
OC-3/STM-1	155.52 Mbps	Optical fiber	Large company backbone Internet backbone
E-5	561.148 Mbps	Optical fiber	Carries 4 E4 channels. Up to 7,680 simultaneous voice conversations
OC-12/STM-4	622.08 Mbps	Optical fiber	Internet backbone
Gigabit Ethernet	1 Gbps	Optical fiber (and “copper” up to 25 meters)	Workstations/networks with 10/100 Mbps Ethernet will plug into Gigabit Ethernet switches
OC-24	1.244 Gbps	Optical fiber	Internet backbone
SciNet	2.325 Gbps (15 OC-3 lines)	Optical fiber	Part of vBNS backbone
OC-48/STM-16	2.488 Gbps	Optical fiber	Internet backbone
OC-192/STM-64	10 Gbps	Optical fiber	Backbone
OC-256	13.271 Gbps	Optical fiber	Backbone

Key and Explanation
We use the U.S. English "Kbps" as the abbreviation for "thousands of bits per second." In international English outside the U.S., the equivalent usage is "kbits s-1."

Engineers use data rate rather than speed, but speed (as in "Why isn't my Web page getting here faster?") seems more meaningful for the less technically inclined. Many of us tend to think that the number of bits getting somewhere over a period of time is their speed of travel.

Relative to data transmission, a related term, bandwidth or "capacity," means how wide the pipe is and how quickly the bits can be sent down the channels in the pipe. (The analogy of multiple lanes on a superhighway with cars containing speed governors may help. One reason why digital traffic flows faster than voice traffic on the same copper line is because digital has managed to convert a one-lane or narrowband highway into a many-lane or broadband highway.)

These "speeds" are aggregate speeds. That is, the data on the multiple signal channels within the carrier are usually allocated by channel for different uses or among different users.

Key: "T" = T-carrier system in U.S., Canada, and Japan...."DS"= digital signal (that travels on the T-carrier or E-carrier)..."E" = Equivalent of "T" that uses all 8 bits per channel; used in countries other than U.S. Canada, and Japan...."OC" = optical carrier (SONET)...."STM" = Synchronous Transport Modules (SDH)

Only the most common technologies are shown. "Physical medium" is stated generally and doesn't specify the classes or numbers of pairs of twisted pair or whether optical fiber is single-mode or multimode. The effective distance of a technology is not shown. There are published standards for many of these technologies. Some of these are indicated on pages linked to from the table.

Cable modem note: The upper limit of 52 Mbps on a cable is to an ISP, not currently to an individual PC. Most of today's PCs are limited to an internal design that can accommodate no more than 10 Mbps (although the PCI bus itself carries data at a faster speed). The 52 Mbps cable channel is subdivided among individual users. Obviously, the faster the channel, the fewer channels an ISP will require and the lower the cost to support an individual user.[38]

Current Data Connection Costs

Connection Type	Monthly Service Fee	ISP Charges	Additional Fees
Cable Modem			
@Home	$39.95-$49.95*	Included in service fee	Cable hook-up
Road Runner	$44.95-$54.95[39] dynamic IP address	Included in Service fee	Installation: $49.95-$69.95
DSL			
Texas.Net Cable Modem DSL Service	$39.00/mo for SWB	$19.95/mo for Texas.Net	?
Jump.net ADSL	$39.95-$69.95 (384Kx128K) $169.95-$199.95 (1,5Mb-384K)[40]	Includes the price of the SWB circuit	$49.95-$59.95 set up fee; hardware ?
Jump.net Symmetric DSL	$99.95-$495.95 (160K-1.5Mb)	Includes the price of the SWB circuit	Recommend Netopia Router
SWBell ADSL	$39-$129[41]	$40-$70	$298 for Alcatel 1000 ADSL modem; Alcatel POTS Splitter;

[38] Burgess, Colvin, Dalit Eizen, Laurence Heine, Matt Gumbel, Matt Holdrege, Robert Orendain, Tom Sealey, Simon Smith, and Patrick Tierc. (1999, July). *Whatis.Com.* Data Rates. [Online]. Available: http://www.whatis.com/ [1999, October 23].

[39] Time Warner Cable. (1999, May). [Online]. Available: http://www.austin.rr.com/twaustin/pricing.html [1999, October 23].

[40] Jump.net. [Online]. Available: http://dsl.jump.net/ [1999, October 23].

			Network Interface Card (NIC); On-site DSL Equipment Installation
Dial-Up Modem			
Telesys	$9.00	Included in service fee.	Possible toll charge
Commercial ISP	$10-$20	Included in service fee.	Possible toll charge
ISDN			
SWBell ISDN	$21.95 for BRI[42]	Included in service fee.	Set up fee $21.95; ISDN adapter $300[43]

*Pricing is for residential service and varies by market. May be higher if you are not a cable TV subscriber.[44]

[41] Southwestern Bell Internet Services (1999, September). [Online]. Available: http://public.swbell.net/dedicated/dsl_enhanced.html [1999, October 23].
[42] Southwestern Bell Internet Services (1999, September). [Online]. Available: http://public.swbell.net/ISDN/index.html [1999, October 23].
[43] Whatis.com. (1999, October). ISDN. [Online]. Available: http://www.whatis.com/ [1999, October 23].
[44] @Home. (1999, October). [Online]. Available: http://www.home.com/pricing.html [1999, October 23].

Section 5 Appendix C

Learner Tools															
Web Browsing	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
Accessibility	1		1						1			1			1
Bookmarks	1	1	1	1		1	1	1	1	1	1	1	1	1	1
Multimedia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Security	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	4	3	4	3	2	3	3	3	4	3	3	4	3	3	4
Asynchronous Sharing	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
E-mail	1	1	1	1	1	1	1	1	1	1	1	1		1	1
BBS_file_exchange	1	1	1	1	1	1		1	1	1	1	1		1	1
Newsgroups	1	1	1	1	1	1	1	1	1	1	1	1		1	1
	3	3	3	3	3	3	2	3	3	3	3	3	0	3	3
Synchronous Sharing	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
Chat	1	1	1	1	1	1	1	1	1			1		1	1
Whiteboard	1	1		1	1		1	1	1					1	1
Application_sharing	1	1					1	1	1						
Virtual space								1							1
Group browsing	1	1					1	1							1
Teleconferencing		1	1				1	1	1						1
Videoconferencing		1	1				1	1	1						1
	4	6	3	2	2	1	6	7	5	0	0	1	0	2	6
Student tools	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
Self-assessing	1	1	1	1	1	1		1	1	1	1	1	1	1	1
Progress_tracking	1	1	1	1	1	1	1		1	1	1	1	1		1
Searching	1	1	1	1					1				1	1	
Motivation_building	1	1	1	1	1	1		1	1	1	1	1	1		1
Study_skill_building	1	1	1	1		1	1	1		1	1		1		
	5	5	5	5	3	4	2	3	4	4	4	3	5	2	3
Support Tools															
Course	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM

Course_planning	1	1	1	1	1	1	1	1	1	1	1	1	1		
Course_managing	1	1	1	1	1	1	1	1	1	1	1	1	1		1
Course_customizing	1	1	1	1	1	1	1	1	1	1	1	1	1		
Course_monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1		1
	4	4	4	4	4	4	4	4	4	4	4	4	4	0	2
Lesson	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
Instructional_designing	1	1	1	1	1	1	1	1	1	1	1		1		1
Presenting_information	1	1	1	1	1	1	1	1	1	1	1		1	1	
Testing	1	1	1	1	1	1	1	1	1	1		1	1	1	
	3	3	3	3	3	3	3	3	3	3	2	1	3	2	1
Data	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
Marking_on-line	1	1	1	1	1	1	1		1	1				1	1
Managing_records	1	1	1	1	1	1	1		1	1	1		1	1	
Analyzing_and_tracking	1	1	1	1	1	1	1			1	1			1	
	3	3	3	3	3	3	3	0	2	3	2	0	1	3	1
Resource	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
Curriculum_Managing	1		1		1			1	1				1		
Building_knowledge	1	1	1	1	1	1			1	1	1		1		
Team_Building	1	1		1	1	1				1	1	1	1	1	
Building_motivation	1	1	1		1					1	1		1	1	
	4	3	3	2	4	2	0	1	2	3	3	1	4	2	0
Administration	IL	LS	G21	CT	CB	CI	TB	LL	OL	5 T C	VU	FC	KS	EQ	LM
Installation	1	1	1	1	1	1	1	1		1	1	1	1	1	
Authorization	1	1	1	1	1	1	1	1		1	1	1	1	1	
Registering	1	1	1		1		1	1	1			1	1	1	1
On-line_fees_handling	1		1						1						
Server_security	1	1	1	1	1	1	1	1		1	1	1	1		
Resource_monitoring	1	1		1		1	1	1		1	1	1			
Remote_access	1	1	1	1	1	1	1			1	1	1		1	
Crash_recovery	1	1		1	1	1						1		1	
	8	7	6	6	6	6	6	5	2	5	5	7	4	5	1

Help desk	IL	LS	G21	CT	CB	CI	TB	LL	OL	TC	VU	FC	KS	EQ	LM
Student_support	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Instructor_support	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Raw Score of Features	40	39	36	33	32	31	31	31	31	30	28	26	26	24	23
Rank of top 15	1	2	3	4	5	6	6	6	6	10	11	12	12	14	15

Section 5 Appendix D

	IntraLearn	Learning Space	Generation 21	WebCT
Server Platform	RAM 256 MB Disk Space 2 GB WinNT 4.5 running SQL Server 7.0 Unix Server	RAM 64MB and additional 64MB for Learning Server Disk Space 300MB WinNT 4.0 works with Learning Server 2.0 ; Unix Server	RAM 64 MB Disk Space 100MB WinNT 4.0 Unix Server Apple Server	RAM 64MB or 128MB if using Win NT Disk Space 10MB + 2MB / course + 30-70k / student WinNT 4.0 Unix Server
Client Platform	standard web browser	Min. Level Win3.1. System 7.5, OS/2 Warp	standard web browsers	Netscape 2.0 MS IE 4.0
Pricing	$25,000US one-time license fee (unlimited users, students, courses, years of use, etc.) $1,500US per year after the first year includes all software "point" upgrades.			50 to 0.5 cents per student per month, Unlimited Single Server License or Corporate License (per server) : $3000US/year)
Limitations		LearningSpace is v2.5 and Leanrning Server is v2.0 by DataBeam Corp., a subsidiary of Lotus/IBM.		
Options		Advanced Services +$1000,Symetric Processors +$2000		
Customers	Cerro Coso Community College John Carroll U.	Kennesaw State U. Pricewaterhouse Coopers	A.W. Chesterton Ball Aerospace, Caliper CONSECO,	531 US Institutions

	U. of Akron	New Jersey Institute of Technology Hong Kong Polytechnic U. U.of Georgia Terry College of Business U. of Wisconsin	EMC Corp. Evolving Systems EXAMCO INSpire Insurance Solutions, Inc. Lockheed-Martin Modis Training chnologies Novell, Inc., NYPRO Port Arthur Oil Refinery PRI Automation Reliant Energy HL&P Rocky Flats, Simplex Storage Technologies	

	Web Course in a Box	**Blackboard CourseInfo**	**Asymetrix ToolBook**	**LearnLinc**
Server Platform	RAM 64 MB Disk Space 10 MB + 50K or more / course. WinNT 4.0 Unix Server	RAM 32MB Disk Space 32MB WinNT 4.0 Unix Server	64 MB recommended Disk Space 70 MB(up to 300MB for all optional components) WinNT 4.0 Unix Server: Solaris 2.4	64 MB RAM, Disk Space 50 MB for 25 users on a single server ; 25-150 users : Increase 128 MB WinNT 4.0, MS IIS 4.0
Client Platform	Netscape Navigator 3.0 MS IE 4.1	standard web browsers	Netscape Navigator 4.06 MS IE 4.01	Netscape Navigator 4.05 MS IE 4.01
Pricing	Suite (Web Course in a Box, Web Campus in a Box, Web CourseBuilder ToolBox) for $6000	$200-$35 per CourseSite Depends on package	ToolBook II Assistant 6.5 : $1095, Librarian 6.1 : $3,000 per server and $50 per user ;Unlimited users: $50,000	$500 to $1,000 per user (according to the number of users)
Limitati			Requires SQL	

ons			server for Librarian.	
Options	Instructors Support: $2,000 for 10 instructors.	Training Package	ToolBook II Instructor	LearnLinc Communication Options
Customers	Virginia Commonwealth U. (The Home Site of WCB!) Alamance Community College Arizona State U. Austin Community College Belmont U. Bethel College & Seminary Buffalo State College Chowan College Coe College College of Bahamas Darton College Delgado Community College DeVry Institute Drake U. Eastern Oregon U. Eastern Kentucky U. Emporia State U. Farleigh Dickinson U. Florida Community College at Jacksonville Ft. Hayes State U.	Cornell U. Yale U. Georgetown U. U of Nebraska, Lincoln U of Memphis U of Pittsburgh U of Tennessee Tufts U Ithaca City School District Dallas County Community College	California State U, Sacramento Duke University East Tennessee State U Johns Hopkins U Ohio U Washington State U	Kent State U. Berean U. Aetna U.S. Healthcare MCI WorldCom Office Depot

	Garden City Community College Grand Valley State U. J. Sargeant Reynolds Community College Keene State College Latrobe U. LeHigh U. Lewis & Clark College Louisiana College Manhattan College Miami U., Middletown Ohio Mohave Community College Ottawa U. Presbyterian College Providence College Purdue U. Rand Afrikaans U. Randolph Macon College Rider U. Salve Regina U. South Dakota State U. St. Edwards U. Sam Houston State U. Sonoma State U. Truman State U. U. of California, Davis U. of California -			

	Riverside U. of Idaho U. of Kansas U. of Massachusetts Lowell U. of Nebraska at Omaha U. of Wisconsin-Milwaukee			

	OLI	Top Class	Virtual-U	FirstClass
Server Platform	RAM and Disk Space Scalable approach WinNT 4.0	RAM 128MB WinNT 4.0, Mac OS, Solaris, Red Hat Linux 5.2	RAM 128MB Disk Space 6-10GB WinNT 4.0, Solaris, SunOS, HP/UX, Linux with Netscape or Apache	4MB RAM Disk Space 10MB WinNT 4.0, Mac OS
Client Platform	standard web browsers	standard web browsers	MS IE 4.x Netscape 2.x	4 MB RAM to use FirstClass client software
Pricing		50 users:$2,250, 100 users:$3,750 200 users:$4,750	$3,500 per year	400 licenses for: one year renewable license $4,000; perpetual license (which means owning the latest software at the end of the year) $10,280; three year renewable / perpetual license: $10,120 / $13,240
Limitations	Very scalable architecture		Perl is required on NT or Unix	
Options		TopClass Publisher		Work offline with client software
Customers		Arizona State U. Brigham Young U.	15 Canadian universities and colleges	Bellevue University Online The Open

		State U. of New York New York U. California State Universities California Community Colleges Clemson U. Indiana State U. Iowa State U. U. of Georgia Purdue U. Texas A&M U. U. of California U. of Southern California U. of Florida U. of Kentucky Drexel U. U. of London U. College of Dublin National Taiwan U. U. of Technology-Sydney Nottingham U. Helsinki U. Hong Kong Polytechnic U. U. of Georgia U. of Massachusetts Medical College of Wisconsin U. of North Carolina		University JCPenney

	KnowledgeSoft	Eloquent	The Learning Manager
Server Platform	10MB for the application and 3GB for the database	32MB RAM Disk Space 100MB for each hour of content	RAM 192 MB Disk Space is dependent on the

	Win NT 4.0, Sun Solaris 2.5, Netscape Enterprise Server 3.0 or Oracle 7.3	Win NT 4.0	volume of materials WinNT 4.0 MS IIS 4.0 ODBC compliant database : SQL Server, Oracle
Client Platform	Netscape Navigator 3.0 MS IE 3.0		MS IE 4.01
Pricing			US$.50 per student per year with a US$1500 annual minimum
Customers	Acxiom, Amoco, AT&T Chevron, ComputerPREP Hershey Foods, IBM International Learning Systems, McGraw-Hill	AlliedSignal Inc. Ascend Communications FileNET Corp. KidsPeace	Southern Alberta Institute of Technology Pellissippi State Technical Community College

Home page of IntraLearn (IL): http://www.intralearn.com
Home page of Learning Space (LS): http://www.lotus.com/home.nsf/tabs/learnspace
Home page of Generation 21 (G21): http://www.gen21.com
Home page of WebCT (CT): http://homebrew1.cs.ubc.ca/webct
Home page of Web Course in a Box (CB): http://www.madduck.com/index.html
Home page of Blackboard CourseInfo (CI): http://www.courseinfo.com
Home page of Asymetrix ToolBook (TB): http://www.asymetrix.com
Home page of LearnLinc (LL): http://www.learnlinc.com
Home page of OLI (OL): http://www.empower-co.com
Home page of Top Class (TC): http://www.wbtsystems.com
Home page of Virtual-U (VU): http://virtual-u.cs.sfu.ca
Home page of First Class (FC): http://www.softarc.com
Home page of KnowledgeSoft (KS): http://www.knowledgesoft.com
Home page of Eloquent (EQ): http://www.eloquent.com
Home page of The Learning Manager (LM): http://tlm.sait.ab.ca

Reference:

online educational delivery applications: a web tool for comparative analysis
http://www.ctt.bc.ca/landonline
A Survey of New Media Development and Delivery Software for Internet-Based Learning
http://teleeducation.nb.ca/media/environment/index.html
On Journal of Distance Learning Administration http://www.westga.edu/~distance/jmain11.html
Distance Learning - Distance Education Resource List
http://www.dir.state.tx.us/TIC/it_info/distance.htm
Malaspina University-College Library
http://web.mala.bc.ca/library/subres/distance.htm
Learning Technologies Group http://www.learningtechnologies.com

An Overview of Online Educational Delivery Applications
http://www.westga.edu/~distance/marsh23.html
deos-fwl by thread http://www.wested.org/hyper-discussions/deos-fwl

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