MIST/C SYSTEM DESIGN

This document describes the parts of the Moodle Integrated Synchronous Teaching/Conferencing system (MIST/C) and how they work together. Philosophy, installation, test specifications, and integration with Moodle are dealt with in companion articles.

Background

Until recently, synchronous distance education was delivered primarily by television. Today the Internet, combined with the personal computer, offers a means of electronic delivery that can be more effective than television, both educationally and in terms of cost to deliver. While many faculty members are conditioned by "television teaching" to assume that video plus audio is the most effective means of delivery, our experience shows that in many cases audiographics (the combination of audio, prepared graphics, and dynamic graphic annotation) is more effective than video. Moreover, audiographics requires much less network capacity than video and therefore reduces the cost of synchronous course delivery. Therefore we have developed MIST/C for synchronous distance education by integrating open source software from other groups with our own supplemental software.

Because we operate in a major urban area and have many working students, MIST/C is intended to serve regional students who come to campus on rare occasions when they need services or to take exams. This approach is further reflected in our approach to distance teaching, which we call "simulteaching." We use the same software to teach a group of students in the classroom in addition to a number of students over the network at the same time. Classes are recorded as they are sent over the Internet and made available on a server for later playback. The students can and do switch among classroom, Internet live, and Internet playback modes from week to week.

The teaching configuration is shown in Figure 1. The basic parts are:

- The MIST/C client, running on both instructor and student computers
- The Moodle server, including a webserver and database system, which provides an asynchronous Learning Management System and supports MIST/C with access control and file management
- The MIST/C server, which supplements the Moodle server by providing real-time exchange of audio, graphics, text chat, and optional video among the participants in a Moodle "room"
- Instructor and student computers, which can use the Windows, Macintosh, or Linux operating system and must include a web browser (such as FireFox) and a sound capture/playback interface (which most computers today have)
- Internet access, at minimum rate 56 kilobits per second (100 kilobits per second if video is used)
- A projector connected to the classroom computer; because this is driven by the same software used by online students, the whole simulteaching audience receives an identical audiographic presentation.

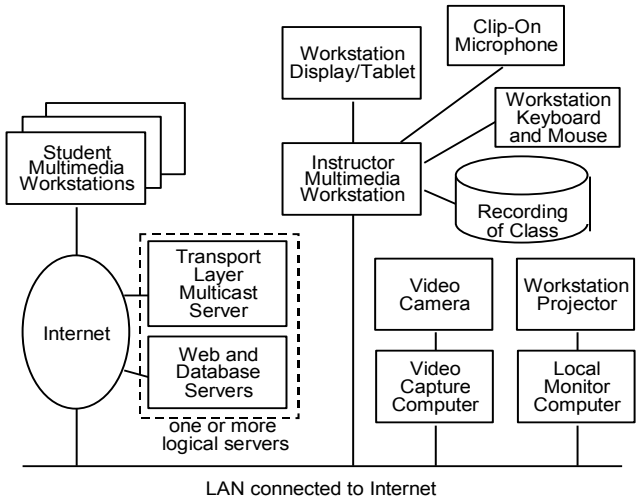

Figure 1. Simulteaching System

MIST/C consists of thirteen highly modular open-source software components as shown in Figure 2. Client versions are available for Windows, Macintosh, and Linux operating systems. The MIST/C server requires a Linux host; normally it is hosted by the same computer that runs the Moodle server.

MIST/C Client Components

Master Client: The multimedia components of MIST/C were developed originally for use in the Internet multicast environment. The Master Client (named TLMC) creates a substitute multicasting environment over a regular network connection, provides TCP tunnels to the MIST/C server, and provides prioritization for data flows from the various client multimedia interfaces. The particular collection of clients and their network configuration to be

used is controlled by an Extensible Markup Language (XML) file that normally is downloaded from the Moodle webserver at the beginning of a MIST/C session. The MIST/C Master Client and Server, along with Floor Control and Record/Playback, are GMU's major contributions to the software system.

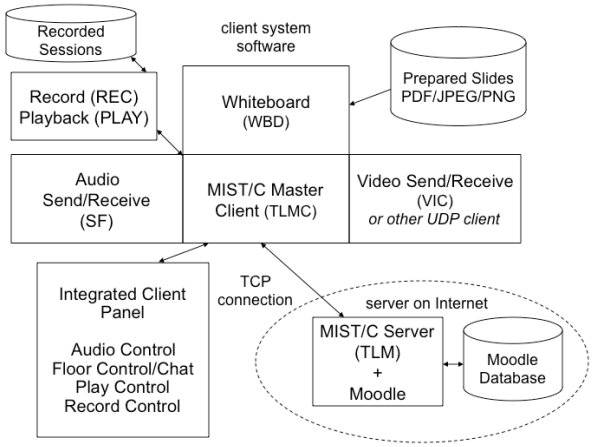

Figure 2. MISTC System Components and Interconnection

Audio (SF): This component is arguably the most important in the system, because it is essential to the students' experience and also because conveying voice with good quality over the Internet at low data rate presents a big challenge. Our adaptation of the Internet voice software Speak Freely (SF) is capable of passing good voice quality over the Internet, using a standard sound interface and requiring only 20 kilobits per second of network capacity.

Whiteboard (WBD): The other key element for teaching online is graphics. This component provides a shared graphic presentation medium that will display a pre-composed graphic prepared in several open formats, most importantly, Adobe Portable Document Format (PDF). These can be annotated with lines, shapes, and text in any color, a very useful feature for maintaining the attention of the visual learner. We prefer to use WBD with an LCD tablet interface so it becomes a surrogate chalkboard.

Video (VIC): We list video after the whiteboard because video is optional in our system, while the WBD is absolutely required. NEW uses an excellent video tool called VIC that is compatible with standard H.323. A typical delivery rate is two frames of 320 by 240 pixels per second, but rates up to 30 frames per second are possible.

Floor Control (FC): This component shows the participants in the session, controls access to the virtual classroom "floor," provides for text questions to the instructor and text chat among the participants, and accepts URLs from the floor holder for browser launch on all participating client systems. It also provides advances functionality:
Application Launching: transports data files from the instructor's desktop to all students desktops, and uses them as data for applications that are started under instructor control

Record (REC) and Record Control: The recorder captures a timestamped stream of messages as seen at a particular user's workstation and records them to disk for playback. RC provides a VCR-like start/stop/pause interface for REC with a display of status and a record counter. Because the data is compressed for network delivery, these files generally require less than ten megabytes per hour of class.

Playback (PLAY) and Playback Control: The player regenerates the original stream of messages from a timestamped recording. It can function as a playback tool for one user or as a server, streaming playback to multiple users. In either case the same clients (TLMC, SF, WBD, and optionally VIC) provide the user interface.

Server Software

Transport Layer Multicaster (TLM): This component implements the multicast paradigm over the general Internet among a group of participating workstations. It provides access control using passwords and optionally using network addresses checked against the MySQL database. It runs on UNIX or Windows systems.

Webserver (Apache): NEW was designed for the Web. We use the Apache open source webserver.

Database (MySQL): We use the open source database access system MySQL which accepts queries in the standard Structured Query Language (SQL). The database provides a unified approach to data management and security across the NEW system and makes possible data access over the network that we are currently using to implement the chat room feature.

Moodle: access control and file storage are provided by standard, open-source Moodle, using a Plug-In we have created, conforming to specifications from Moodle