Network EducationWare (NEW): Open-source Internet Education Software for Academia

J. Mark Pullen, George Mason University

Abstract

NEW is a powerful and robust Internet teaching and conferencing environment based on open-source Internet conferencing software. It consists of distance education software that is highly modular and makes efficient use of both network capacity and human time. NEW is easy to adapt for a wide variety of distance education and conferencing uses. This brief paper provides an overview of the current and planned features of NEW as of the time of writing. Our intention is to provide an economical approach to synchronous distance education for academia by providing high-quality, easy-to-use software shared under the open-source approach.

I. Introduction

NEW is a powerful and robust Internet teaching and conferencing environment based on open-source Internet conferencing software. It is intended to provide distance education software with the following attributes:

- highly modular, based on interconnections via Internet protocols
- makes efficient use of both network capacity and human time
- easy to adapt for a wide variety of distance education and conferencing uses
- provides an economical approach to synchronous distance education for academia
- developed at GMU by adding "glue" functions to other groups' openly available software (keeping all original functions) and adding a few critical pieces
- GMU has cleaned up bugs where necessary
- will be available as academic open-source via <http://netlab.gmu.edu/NEW>

II. Technical Summary

A. Features

1) *Multi-platform:* The current NEW implementation runs under the popular Microsoft Windows™ operating system (any version from Windows98 onward). We plan to provide interoperating versions for Linux and Macintosh OSX in the next year. Each of the current tools has a clear path to become multi-platform; several are already multi-platform, as they were developed in the Java portable programming language.

2) *Multicasting Model:* The best tools we could find for NEW components all were designed for use in a multicast environment, where the underlying network supports sending messages to a group of computers. Unfortunately, multicasting is not widely implemented. Therefore, we have created a capability for transparent support of the multicast transport layer (User Datagram Protocol or UDP) over commonly available unicast Internet Protocol networks. We call the server implementing this the Transport Layer Multicaster (TLM) and have implemented it in such as way at to be completely compatible with network layer multicast. It implements "overlay multicast" using commonly available Internet unicast (host to host) transmission. Our plans call for adding to TLM the ability to chain servers among sites so as to support students at multiple sites efficiently.

3) *TCP Tunnel Option:* The TLM server works with a client on each participating instructor and student host computer. The client provides a "tunnel," associated with the NEW Speak Freely audio client, encapsulating all traffic from the multimedia tools supporting a particular user. The tunnel can use either UDP or the more common Transmission Control Protocol (TCP) which, though less effective for real-time traffic, has the virtue that is works through Network Address translation (NAT) units and also is more likely to be accepted through network security "firewall" barriers.

4) *Authentication:* NEW provides for user access control. Participants are identified by the tuple {*username, password, courseid*}. The authentication is implemented in a Java applet that is launched and runs in common Web browsers such as Netscape™ and Microsoft Internet Explorer™, or as a Java application program using a Java runtime environment.

5) *Multi-speaker Audio with Floor Control:* Any NEW participant with a microphone-equipped computer can send sound to the group, subject to a floor control process moderated by the instructor or other user designated as a controller. The floor control panel shows which users are actively connected and can be used to transfer floor control under the "ask me" mode. Two other modes, "never" and "always," allow uninterrupted lecture and free-form seminars respectively and do not need a floor controller.

6) *Text "Chat":* The floor control panel also includes a capability for any student to send a text message to the whole group at any time. We plan a future option where only the instructor will see these. The text format is very useful for unspoken questions, which might be either from students without microphones, or from senders who do not want to interrupt the person who is speaking.

7) *Remote URL Launch:* The floor control panel also provides for the floor holder (usually the instructor) to enter any Web-accessible Uniform Resource Locator (URL). This could be a hypertext page, a high-resolution graphic object, an audio or video clip, or any other Web object for which the students have client software. The URL will be launched through the browser on each student's computer and replaced or closed at the floor holder's command. The Java application version of the floor control panel has the capability to read a list of URLs from the local computer (Java applets are not permitted to read local files).

8) *Whiteboard for Multi-user Drawing:* The WBD tool supports drawing by any user in the session, in a variety of line widths, colors, and fonts, including variable-size lines, arrows, rectangles and ellipses. Our plans include adding floor control to the WBD, which presently is open to all participants.

9) *Static Whiteboard Slides:* The WBD tool supports importing slides coded in either the Adobe™ open Portable Document Format (PDF) or the much more verbose Postscript open printer language. Once imported, a slide is static, that is it cannot be edited. This capability makes it easy to use lecture slides and other discussion graphics in NEW. The material can be prepared using any Windows application and converted to PDF simply by using the standard print option with Adobe's Acrobat™ commercial software (academic price about US$60; used for authoring only).

10) *Usable Over 56 kb/s Modem:* The audiographic combination of NEW Speak Freely and WBD, along with the Floor Control panel, forms a very adequate basis for synchronous Internet delivery of many courses. This combination is readily supportable for student use over a good connection using a common 56 kb/s modem. This is true even when using the less effective TCP transport protocol. Depending on the type of material used in teaching, instructors are likely to need a little more capacity, either a modem with the UDP tunnel version or a higher-capacity Internet connection such as ISDN, cable modem, Digital Subscriber Line (DSL), or high-capacity campus connection.

11) *Record and Playback:* Using the NEW recorder REC software, the integrated flow of network messages as seen at any NEW Speak Freely/TLM client can be written to a file on that or any other Internet-connected computer. The file can then be played back by the NEW PLAY software, which returns the network messages to the NEW tools on the user's workstation and optionally over the network to other TLM-connected users. The result is that the session, as seen from the computer connected to the recorder, is reproduced identically as it existed when recorded. We have plans for a streaming playback server based on PLAY; at present playback is accomplished by downloading the playback file from a Webserver and running PLAY locally.

12) *Simple Integration on Single or Multiple Computers:* NEW is built to facilitate participation of any multicast tool, either through the multicast group to which the TLM subscribes, or by the tunneling mechanism associated with the TLM Client. We followed the standard network layering approach such that the TLM software forwards the application's messages in a transparent way, completely compatible with network-layer multicasting over UDP. It is possible to gate the flow of messages to the application using NEW floor control if the application can function under that condition (as WBD currently cannot). Further, because all communication among the NEW tools uses Internet protocols, the tools themselves may all be run on a single computer or distributed across multiple computers, either as a unified teaching configuration or as a distributed teaching node, for example placing the recorder in a server facility across campus from the teaching site.

B. System Configuration

Figure 1 shows the relationship of the various multimedia tools in NEW with the TLM server and client modules.

C. User Interfaces

The primary user interfaces of NEW are the NEW Speak Freely audio interface, the WBD whiteboard, and the Floor Control panel. Figure 2 shows these as they might be situated for a

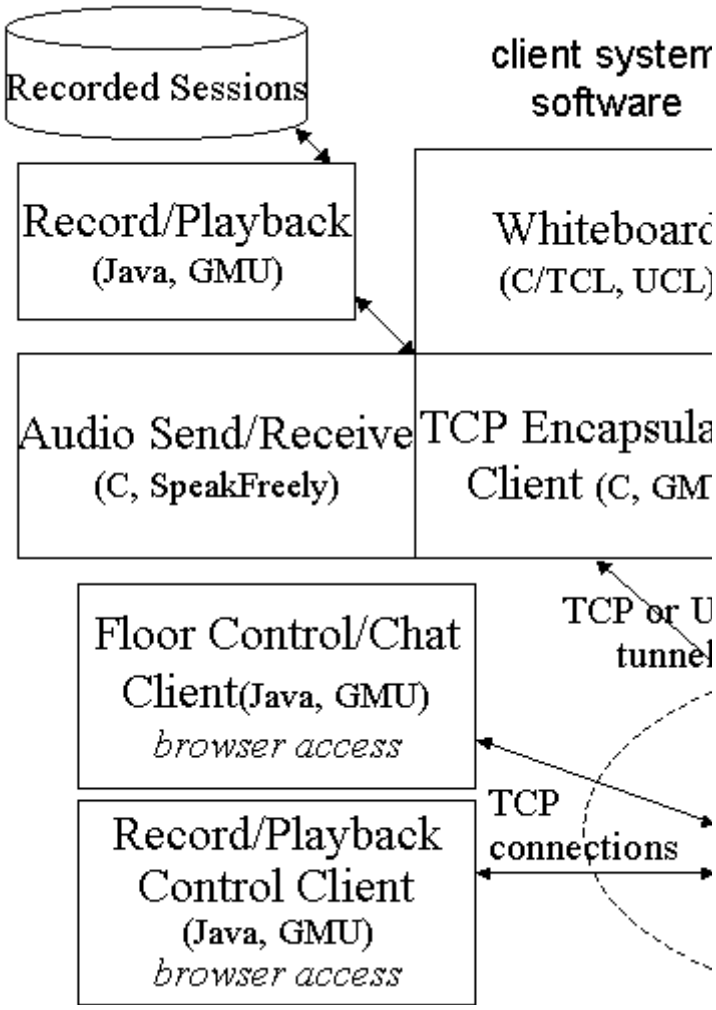

Figure 1. NEW system configuration.

typical teaching session. Each tool interface has been designed very carefully:

- The audio interface includes an outgoing level meter, integrated volume controls, closed loop sound test, and bright red SENDING window.
- The record control is extremely simple: start, stop and pause, with a big reminder window so the user doesn't forget to start it. In a playback configuration the player control would take this place (but without the reminder window).
- The floor control has grid boxes for logged in participants (color coded for quick identification) plus panels for floor request, text send/receive, URL send, and system messages. The version shown is used for teaching so it also has URL list, kill URL, and floor control functions.
- The whiteboard is shown with a sampling of its capabilities: imported static graphics, a dynamically added figure, and a hand-written formula.

The GUI is documented detail and shown in better resolution on the NEW Webpage (see below).

III. Conclusion

At GMU we have experimented with a full range of technologies for synchronous Internet course delivery, and arrived at an optimized system for our needs. We believe it also will prove useful to other academic institutions. We built NEW from open-source software that runs on Windows systems, and intend to extend it to common Unix-based platforms as open-source software. Other academic groups are welcome to download NEW from http://netlab.gmu.edu/NEW.

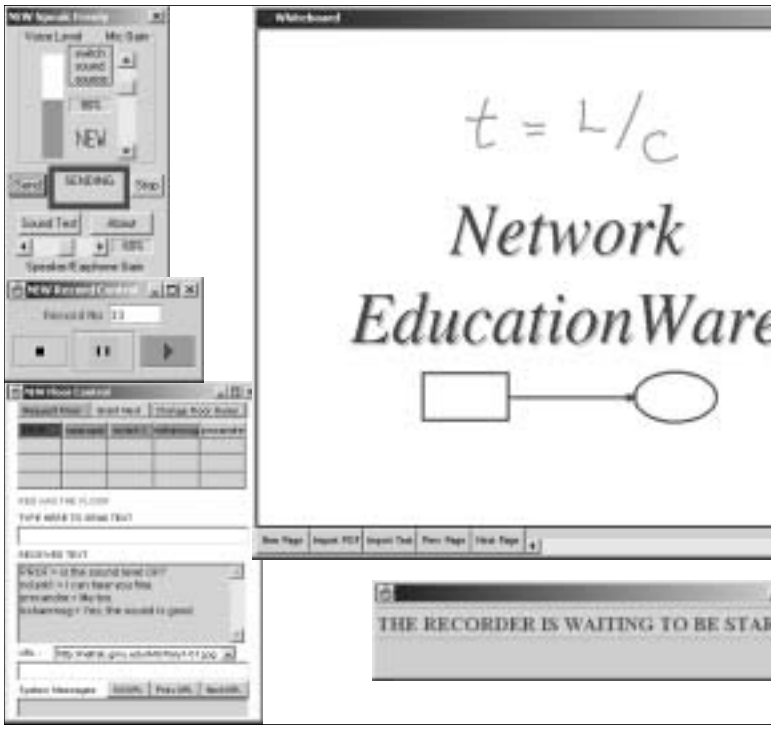

Figure 2. Teaching screen showing NEW graphic user interface.

Acknowledgments

The Speak Freely open source audio tool was developed by John Walker (see http://www.fourmilab.ch/). The VIC tool is open source from University College London (UCL), U.K., and itself owes much to the predecessor VIC from the Lawrence Berkeley National Laboratory Network Research Group and University of California, Berkeley. The WBD tool also is open source from UCL; it was originally developed by Loughborough University in the U.K., and had some important bug fixes by Jon "Sheer" Pullen. The NEW record/playback was developed by Babu Shanmugam of the GMU C3I Center Networking and Simulation Laboratory as a Master's project in Computer Science, while the NEW Floor Control was developed by Manjeera Parupalli of the same laboratory under funding from the U.S. National Library of Medicine. Original source documentation is available through the Website referenced above.

Author's Biography

J. Mark Pullen is Professor of Computer Science at George Mason University, where he heads the Networking and Simulation Laboratory in the C^{3}I Center. He holds BSEE and MSEE degrees from West Virginia University, and the Doctor of Science in Computer Science from the George Washington University. He is a licensed Professional Engineer, Fellow of the IEEE, and Fellow of the ACM. Dr. Pullen teaches courses in computer networking and has active research in networking for distributed virtual simulation and networked multimedia tools for distance education. He is the developer of the Network EducationWare (NEW) open-source suite of tools for synchronous Internet distance education.