

Synchronous Internet Distributed Education Technology

J. Mark Pullen

Department of Computer Science and C³I Center

George Mason University

Fairfax, VA 22032

mpullen@gmu.edu

Overview of Presentation

- Motivation
- Dimensions of Online Teaching
 - media, systems, temporality
- Experience
- Network EducationWare
- SpeakFreely Internet Voice Software

Motivation for Online Lecturing

- March of “progress”
 - commuting to class increasingly frustrating
 - good performance Internet available throughout our region
- Technology can improve use of student time
 - webpages are an improvement over books and handouts
 - virtual classroom can save commuting time
 - student-instructor interaction must be preserved

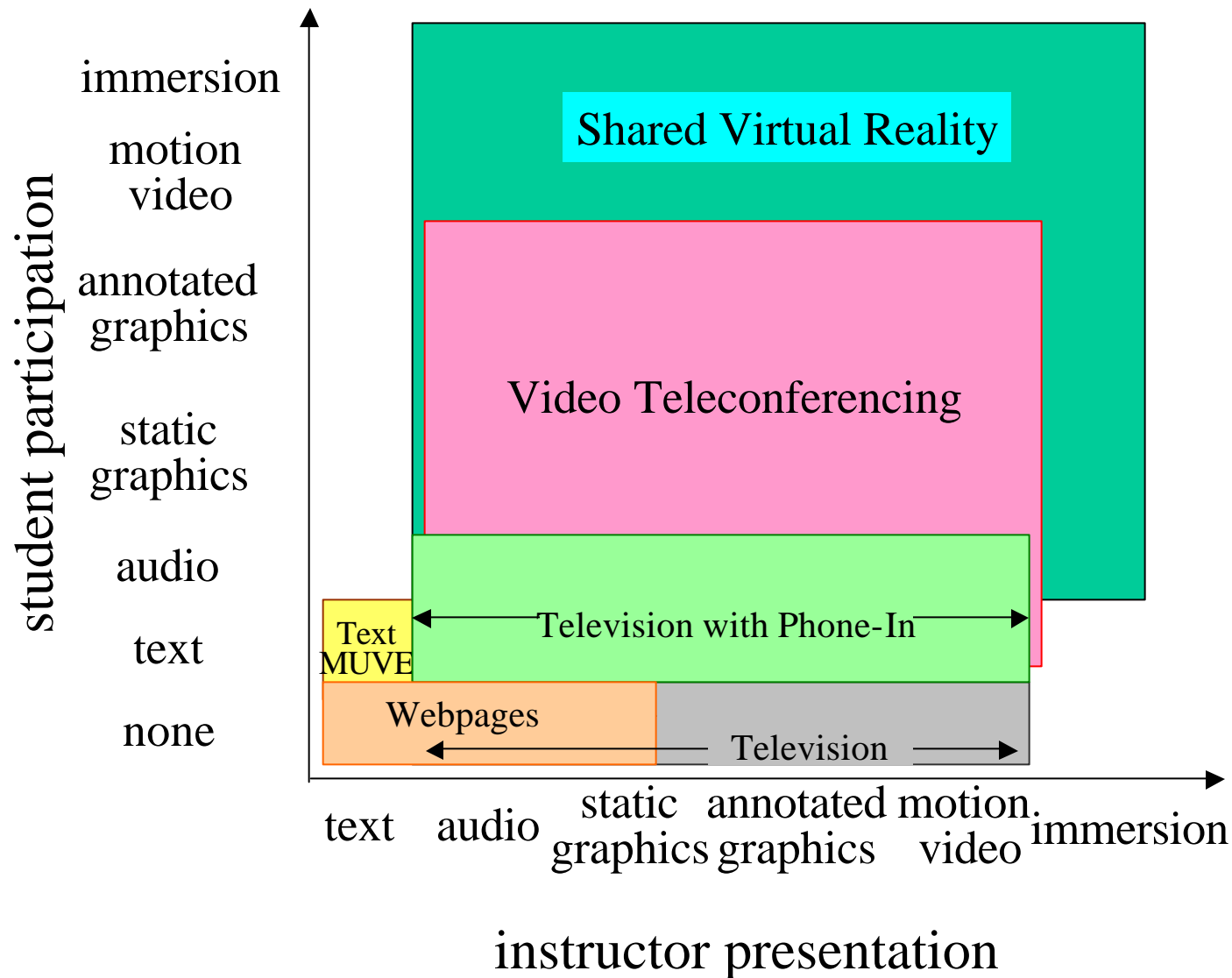
Dimensions of Online Teaching

- Context: teaching by lecture
 - the least effective means of teaching?
 - yes, except for all the others!
 - essence of the problem:
student-instructor interaction
- Why has lecture persisted?
 - focuses student attention
 - provides for delivery in the most current context and idiom
 - efficient use of student and teacher time when students know little about the topic

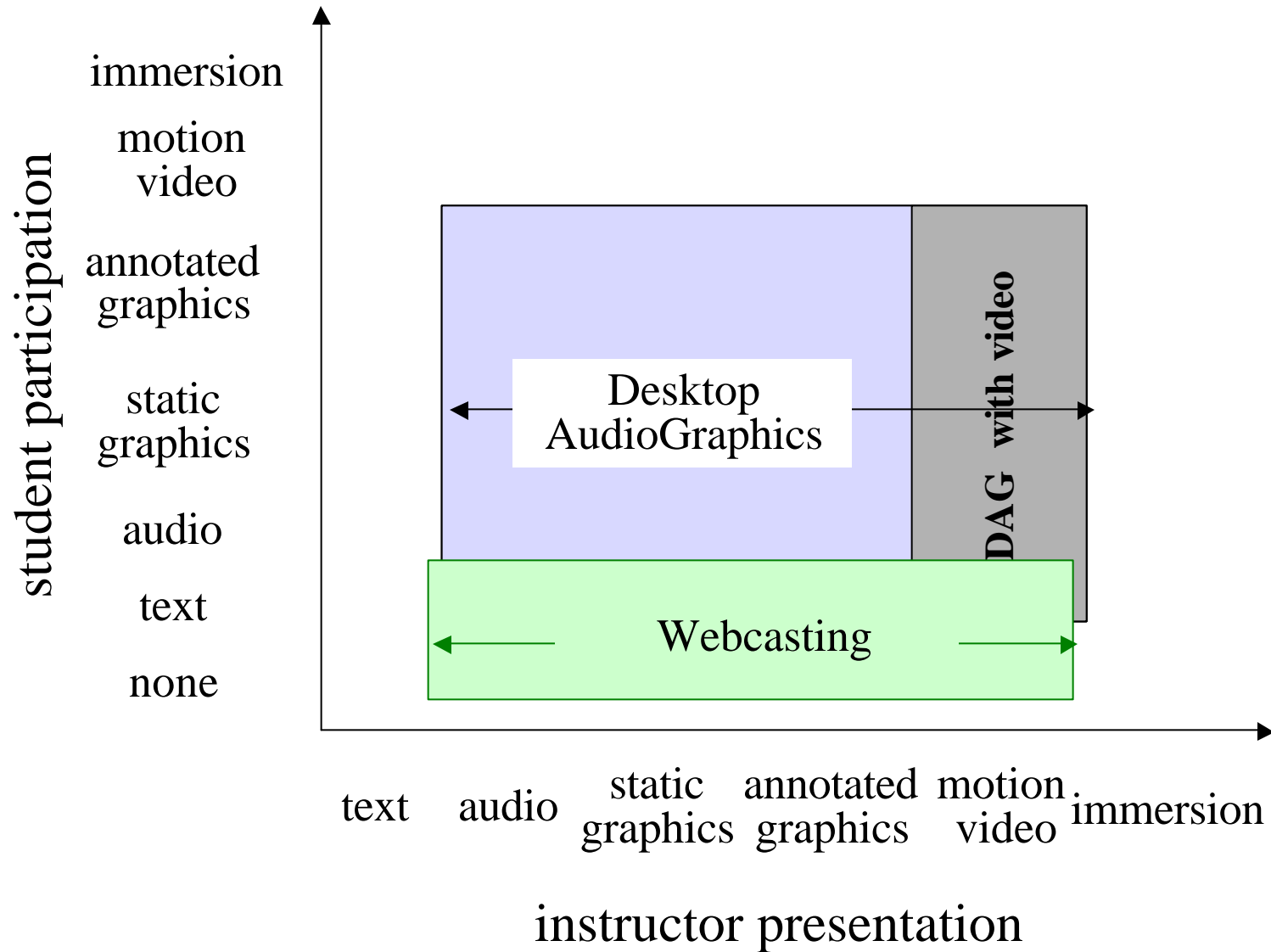
Issues in Online Teaching

- Presentation/participation media
- Systems for online teaching
- Temporality
 - closed-loop response time for questions

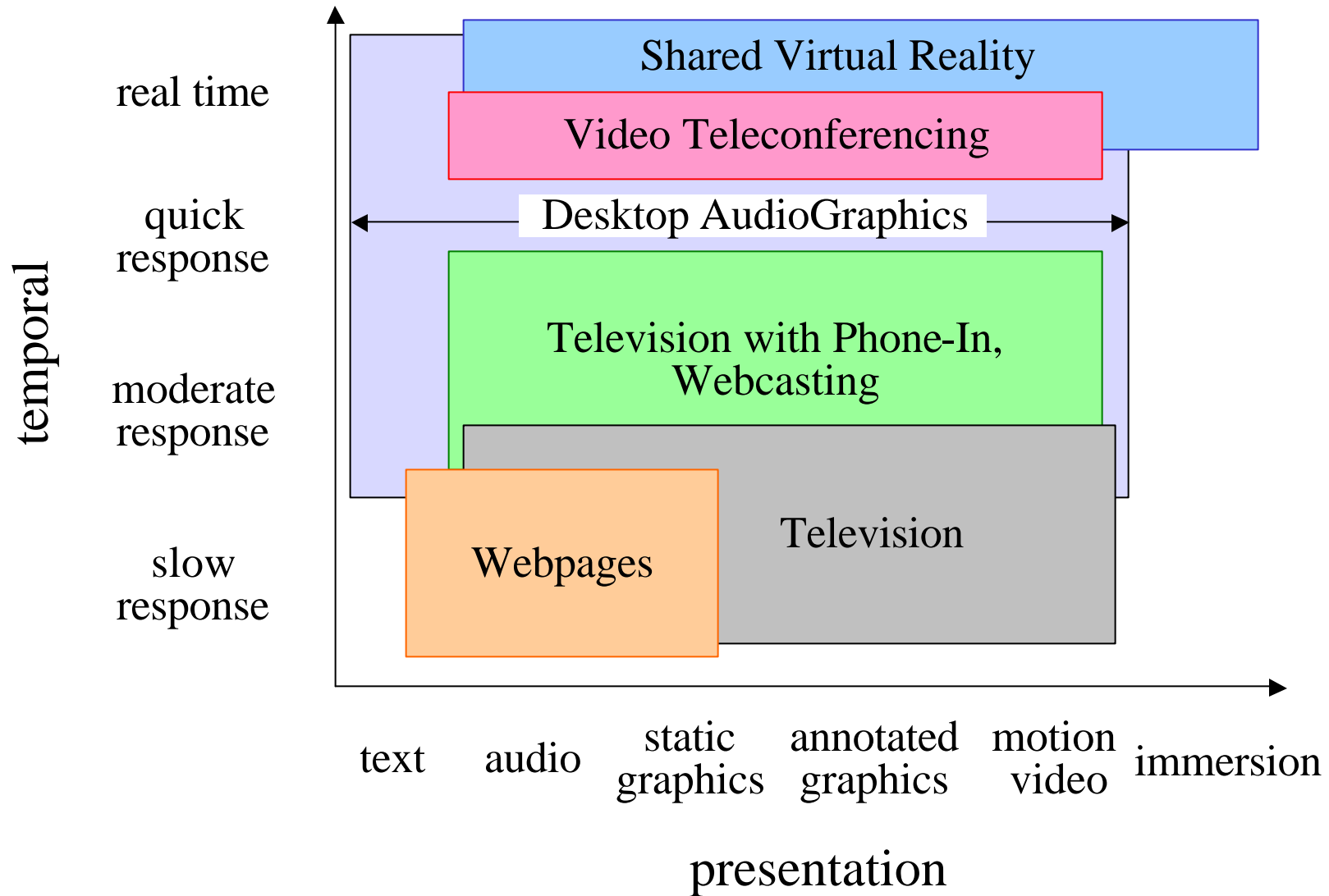
Presentation/Participation Media



Multimedia Systems for Online Teaching



Temporality of Student Interaction



The Right Mix

- All materials accessed via Web browser
- Desktop audiographics virtual classroom
 - preloaded static graphics
 - streaming audio and annotations
 - text response
- Two types of asynchronous support
 - recorded audiographics for server playback
 - ordinary webpages for enrichment

Experience with Online Lectures

- Internet Literacy courses
 - used MBone tool suite
 - audio
 - video
 - whiteboard graphics
 - text
 - designed for multicast
 - also can be used unicast
 - bandwidth-intensive but effective
 - regionally in Northern Virginia
 - USDoD teachers in Germany/Italy

More Experience

- Introductory Networking courses
 - local and remote students
 - LiveBoard™ with ClassWise™ in classroom
 - ClassWise on student Windows™ systems at home or office
 - well received by students
 - <http://netlab.gmu.edu/pubs/ClassWise>

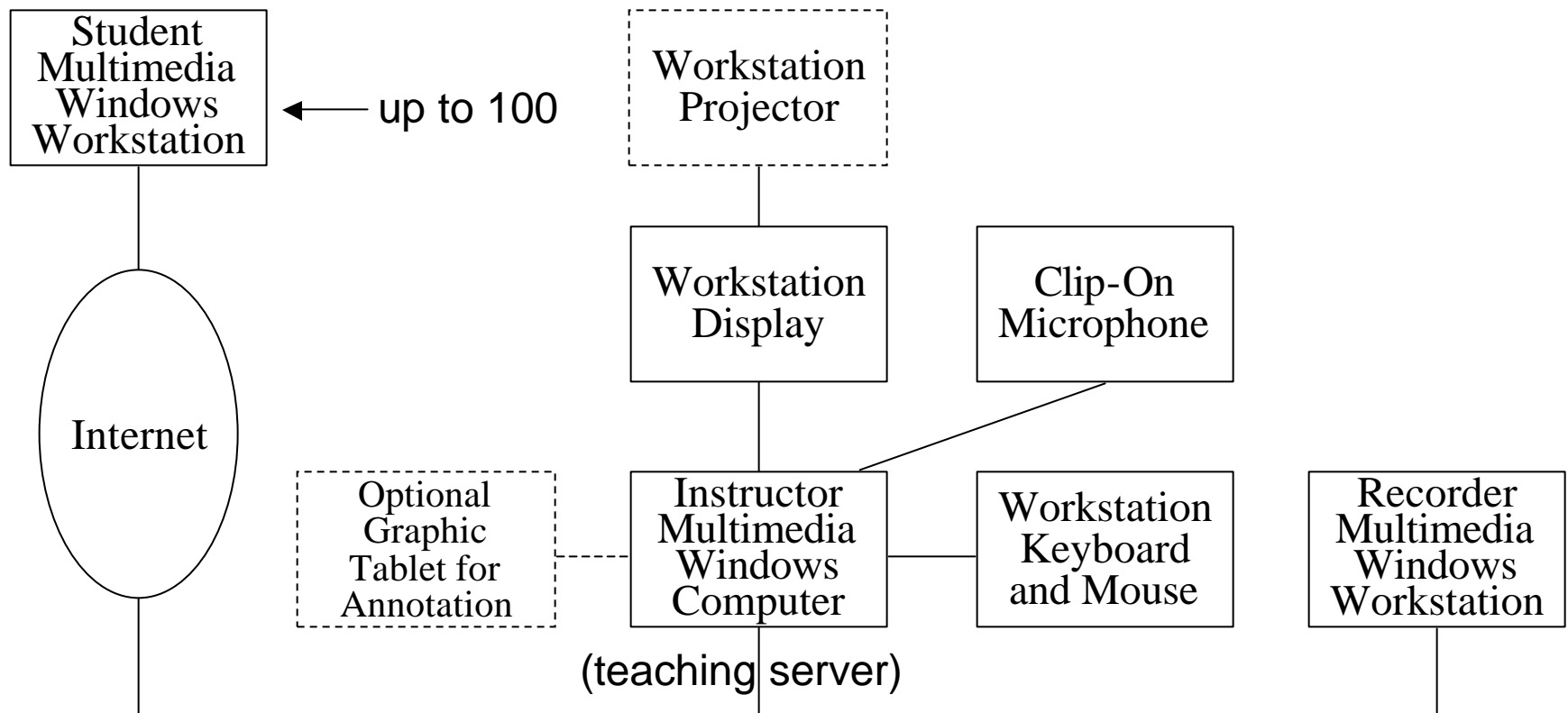
More Experience

- Graduate-level seminar course
 - local and remote students
 - student discussions/presentations
 - presentations worked well
 - problem with discussion: audio pickup for classroom students

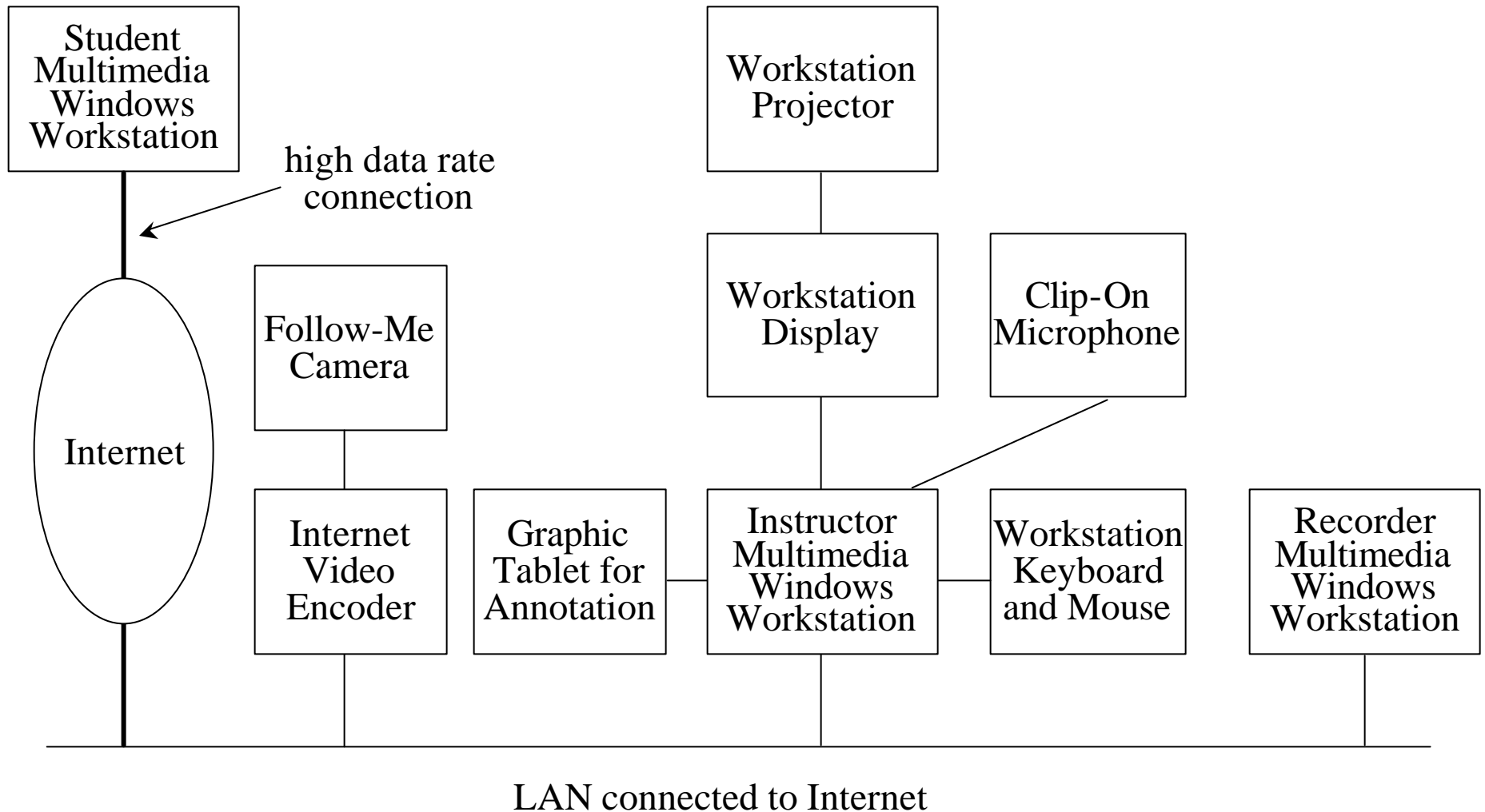
More Experience

- Professional education in Network Engineering
 - all students remote from instructor
 - pilot course presented synchronously
 - now asynchronous because of low student density
 - students like this because of schedule flexibility
 - but many lack self-discipline to complete asynchronous courses

GMU ClassWise Teaching Setup



Audiographics Plus Web Video



Student Comments on Video

- 9 - video provided no value
- 6 - lack of synchronization between audiographics and video was distracting
- 4 - primary use of the video is to let the student know whether class has actually started
- 2 - video helped to focus on the lecture
- 2 - complained about quality of the video
- 2 - stated the video quality was good

Student Attitudes About Live Video

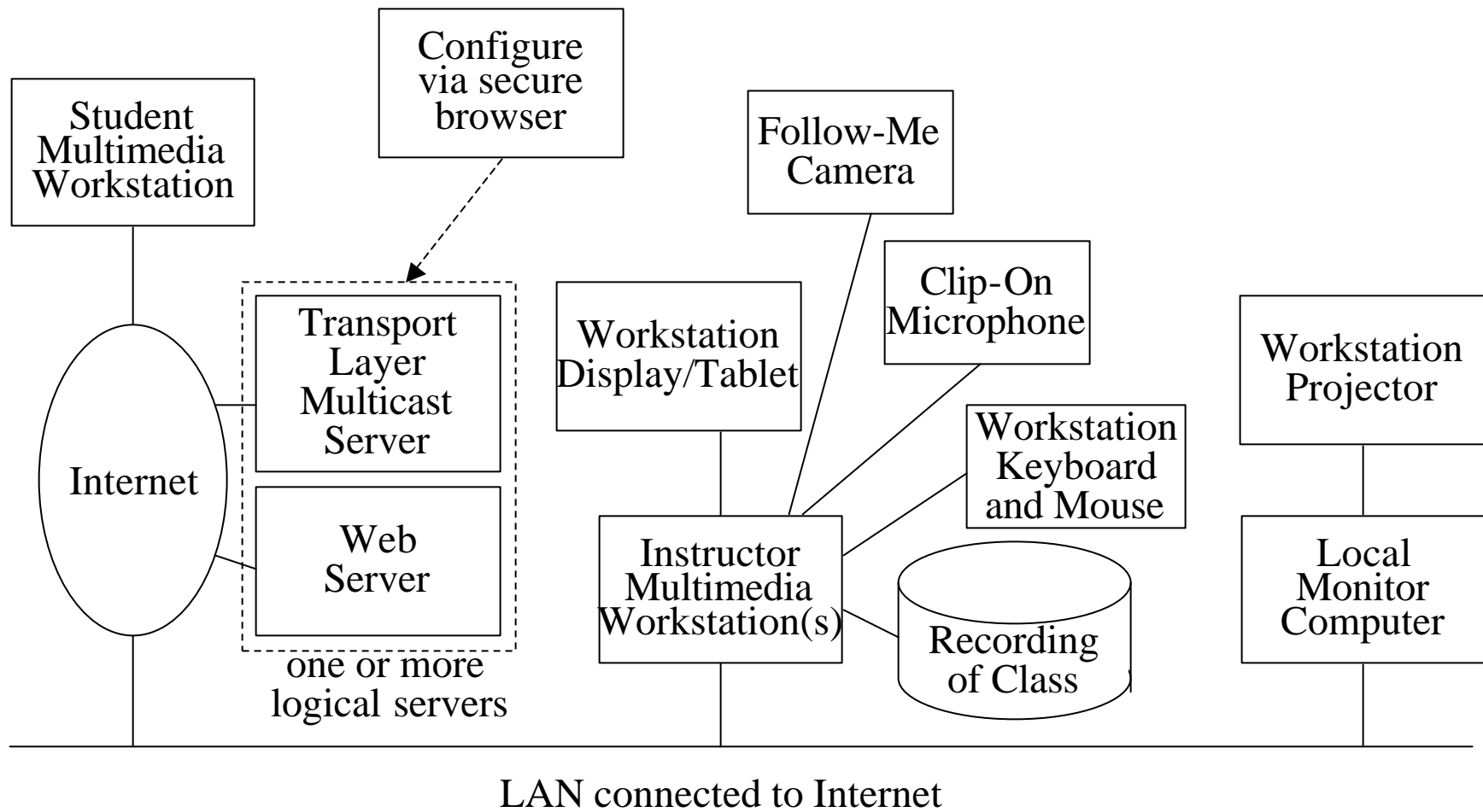
Out of 19 students:

- 2 (11%) were positive
- 5 (26%) were neutral
- 12 (63%) were negative

We are continuing to provide live video in response to those who find it beneficial.

Conclusions on Video Internet Teaching

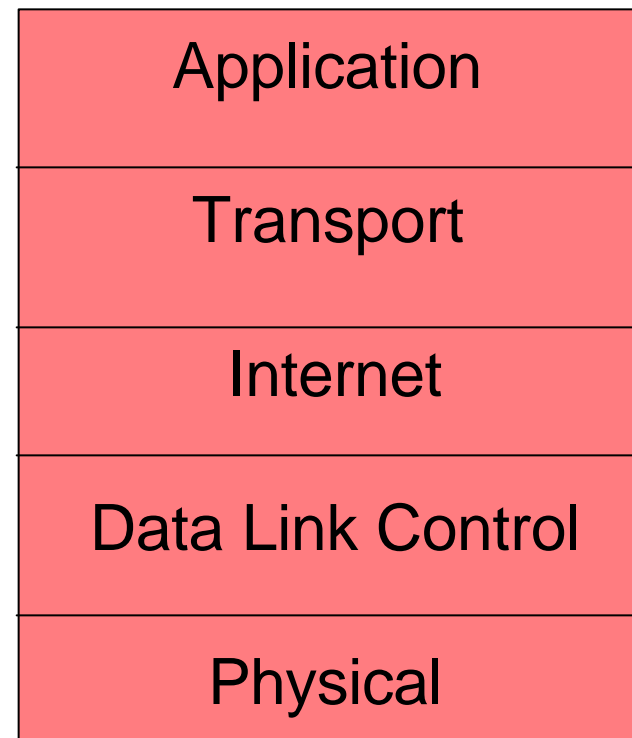
- Providing live video is an economic decision
 - some students say they benefit from it
 - most are neutral or say they do not benefit
 - cost of equipment is not high (under \$10K and can be used for many classes)
 - but network capacity to support many streams at 100 kb/s each could be too expensive for the benefit
 - and more students will be in a position to access live video as DSL and cable modems proliferate
- Audiographics can support five times as many students over the same network capacity



NEW Target Distance Education System Hardware

Multicasting Approaches for Group Communication

- Application layer sends multiple messages
- Transport layer reflector duplicates messages
- Network layer duplicates packets

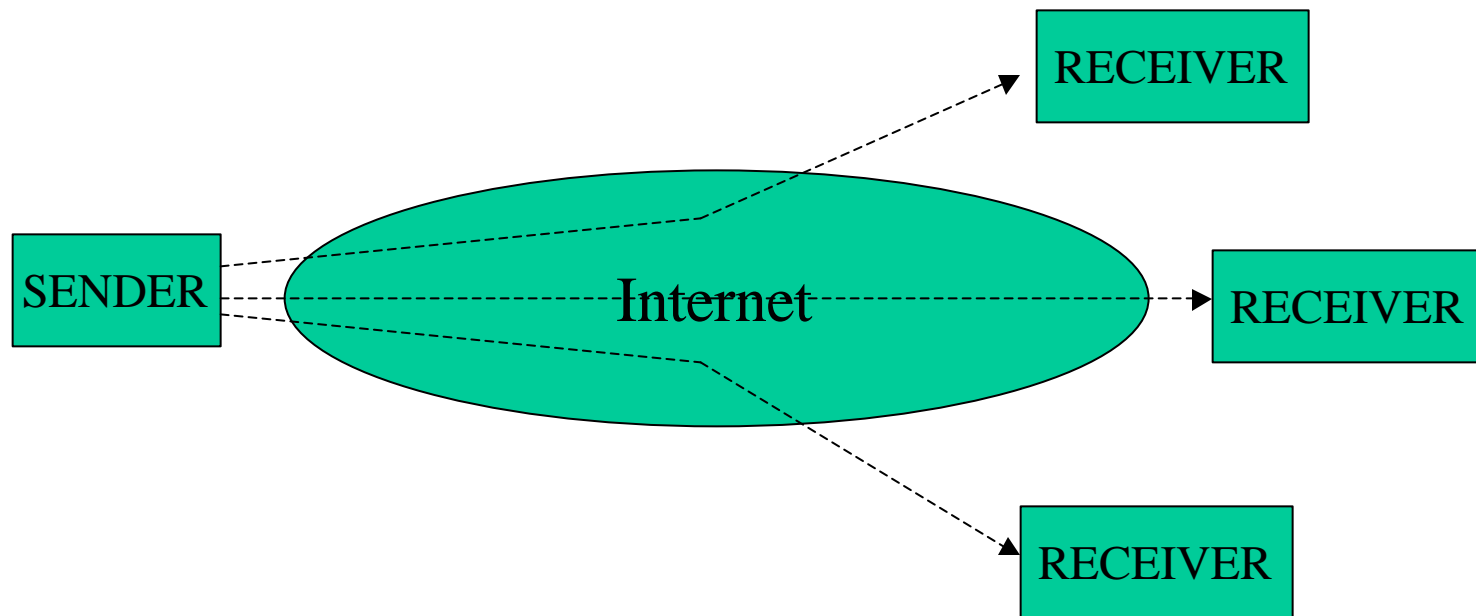


Internet Transport Protocols

- **UDP - User Datagram Protocol**
 - (“unreliable data protocol”)
used for best-effort real-time services
- **TCP - Transmission Control Protocol**
 - reliable transport with automatic
retransmission and congestion control

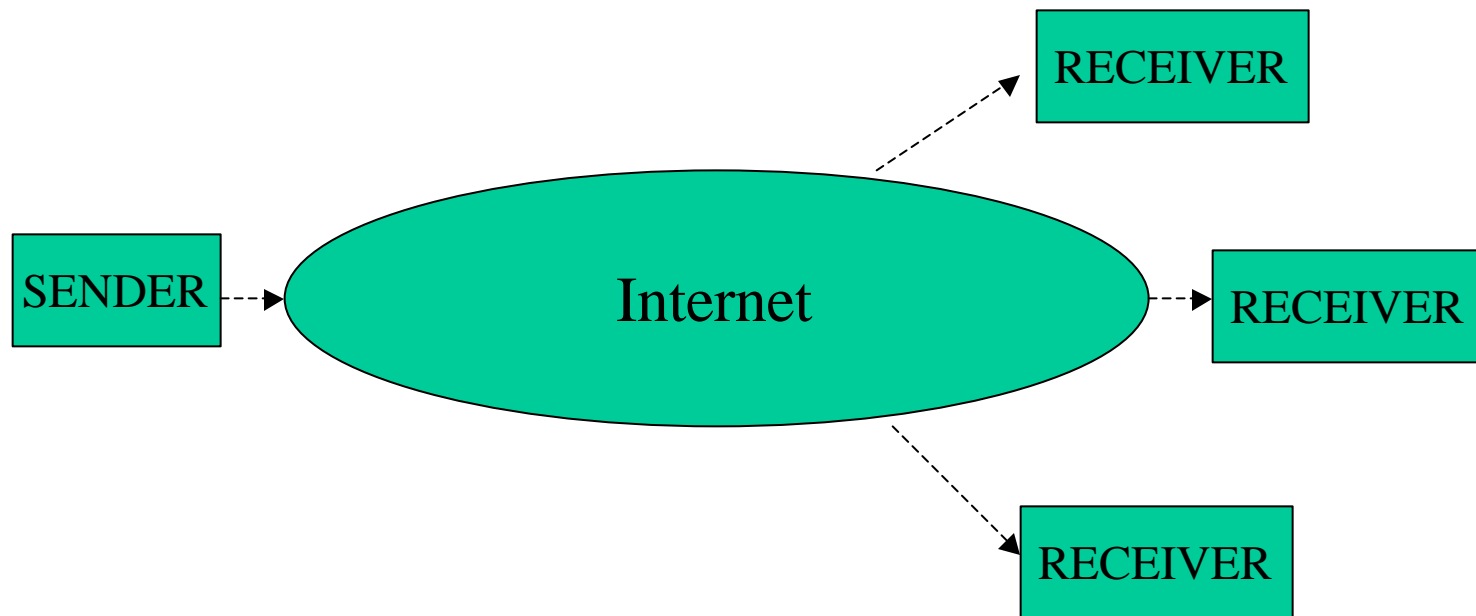
Multicasting Approaches for Group Communication

Application layer sends multiple messages



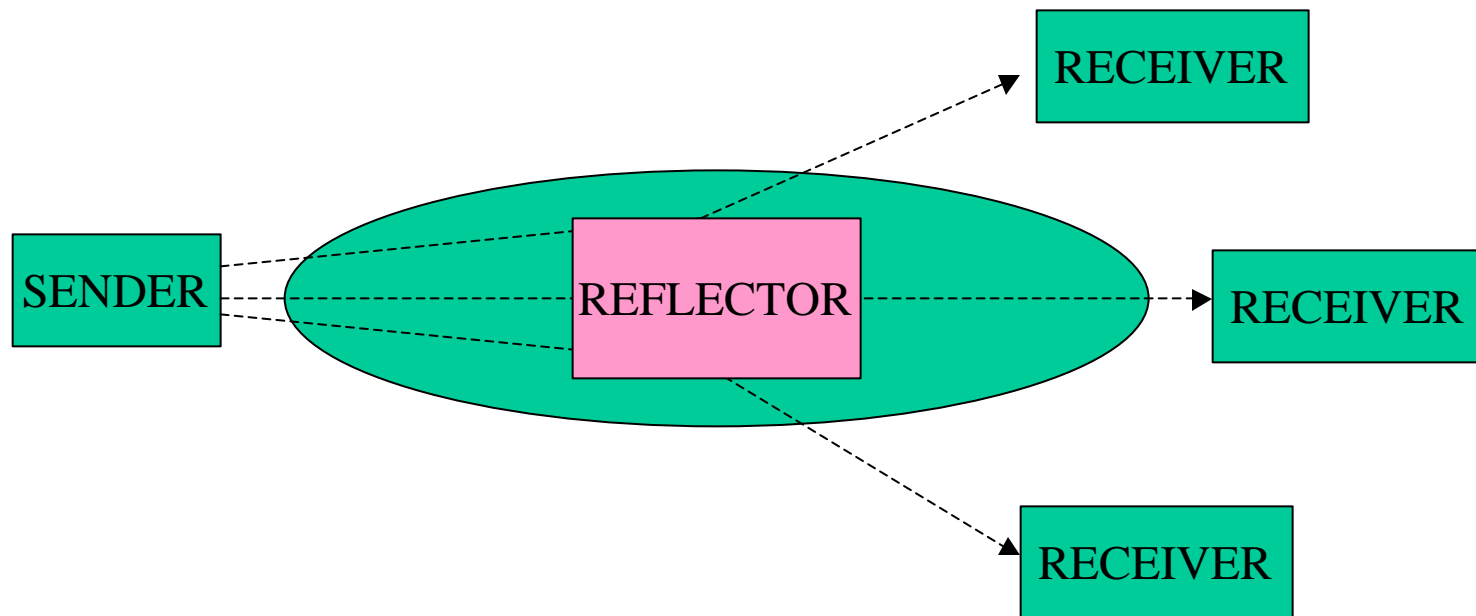
Multicasting Approaches for Group Communication

Network layer duplicates packets



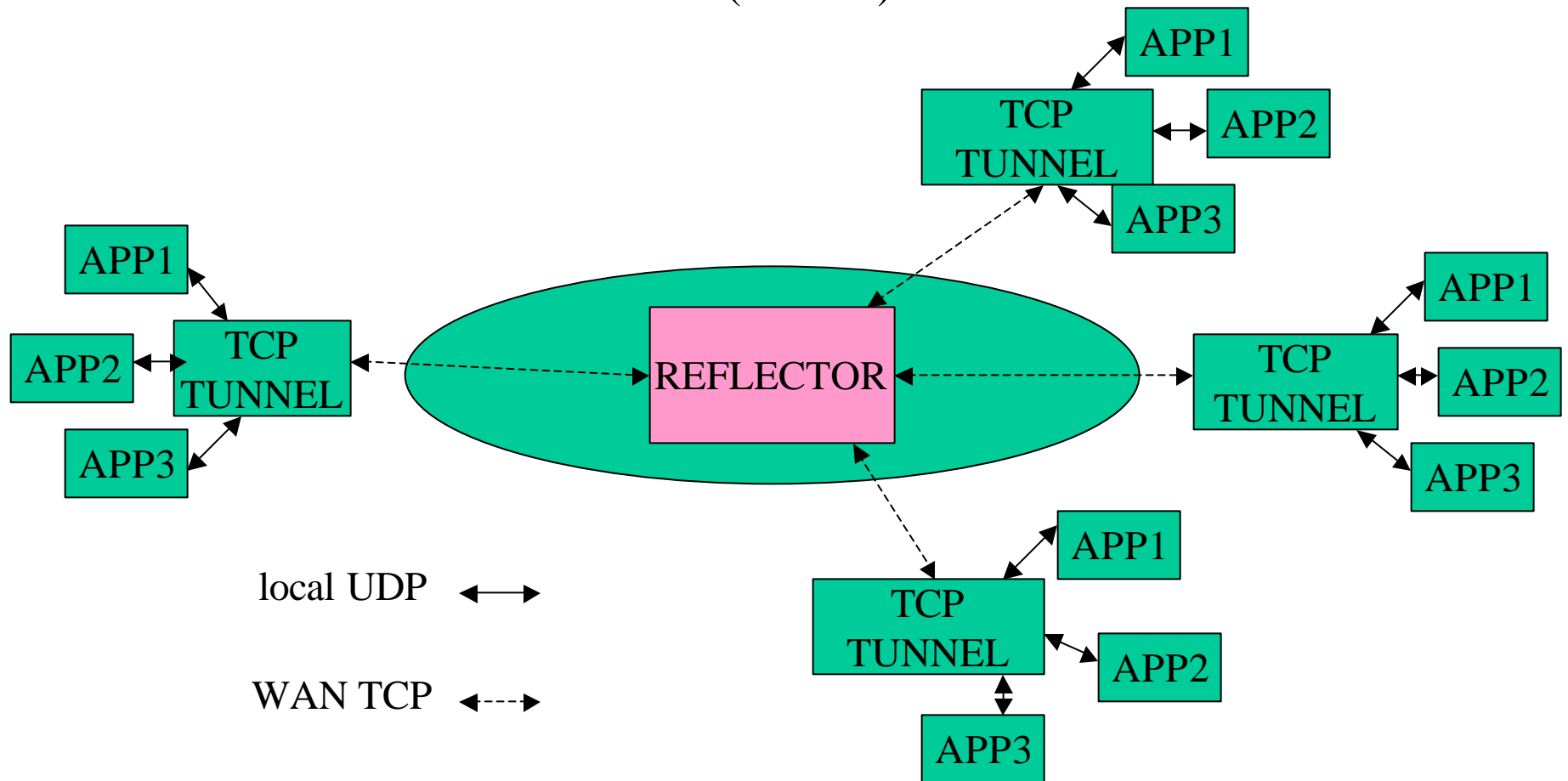
Multicasting Approaches for Group Communication

Transport layer reflector duplicates messages
(UDP/IP)



Multicasting Approaches for Group Communication

Transport layer reflector duplicates messages
(TCP/IP)



GMU C3I Center Networking and Simulation Laboratory

NEW Network EducationWare Project

Architecture:

- multi-platform
 - starting with Windows- Linux & MacOSX later
- server provides transport layer (end system) multicast
- TCP tunnel option for firewall/NAT traversal, security
- facilities for authentication with web-based access
- record and playback at any site under central control
- easy to integrate any multicast-based tool
- tools may optionally be distributed over multiple computers

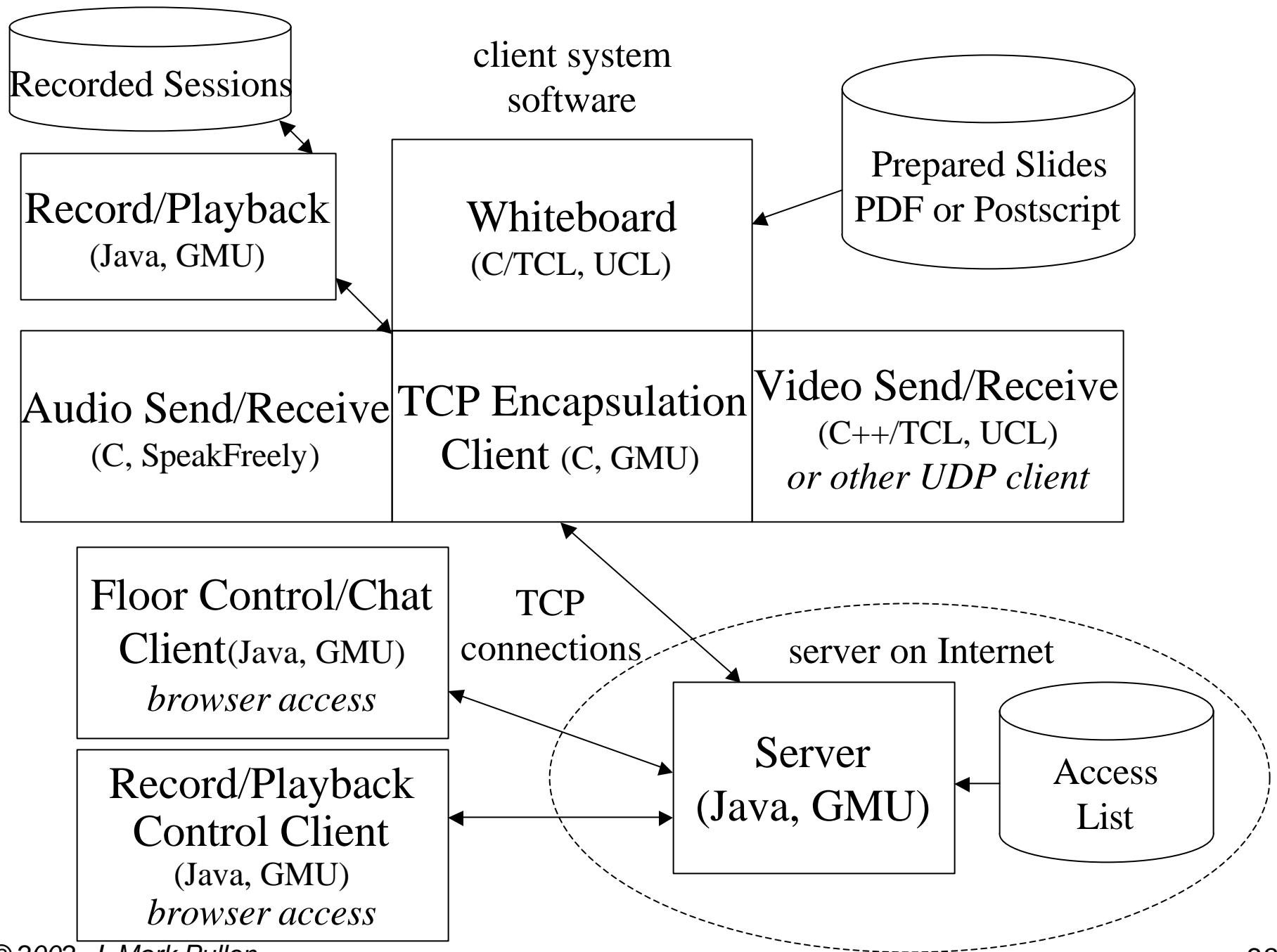
GMU C3I Center Networking and Simulation Laboratory

NEW Network EducationWare Project

Multimedia

- robust, multi-speaker audio with floor control
- text chat with remote URL / browser launch
- whiteboard supports multi-site drawing
- authoring of whiteboard slides in PDF or postscript
- usable over 28.8K modem links (without video)

All *NEW* software is Open Source



MBone Tools in NEW

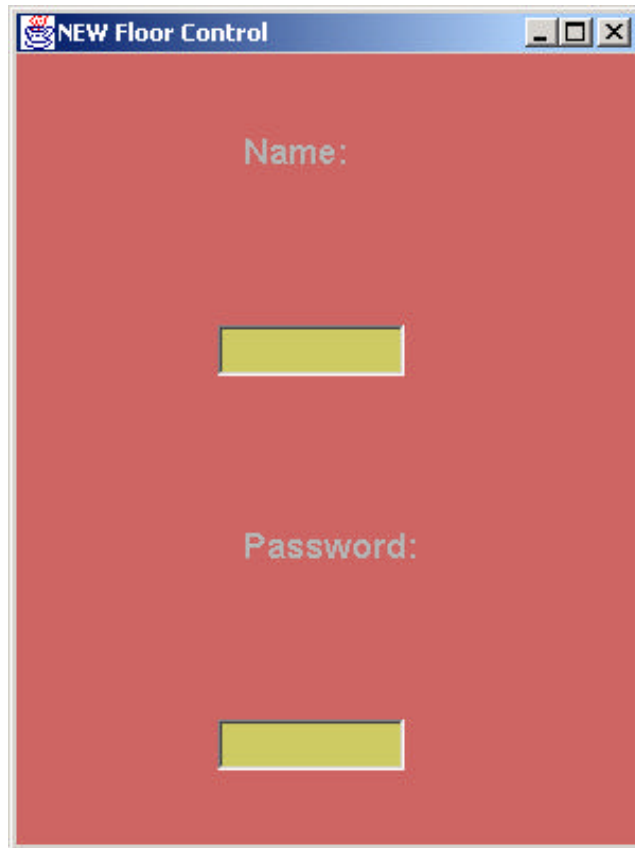
C and/or C++

- WBD
 - whiteboard derived from LBL “WB”
 - static material coded in Adobe PDF or postscript
 - annotation text, rectangle ellipse, line arrow
 - multiple colors, fonts, line-widths
- VIC
 - Video Internet Conference over Windows
 - inexpensive Videum capture unit
 - supports multiple standards including H261, H263

NETLAB Contributions to NEW Java

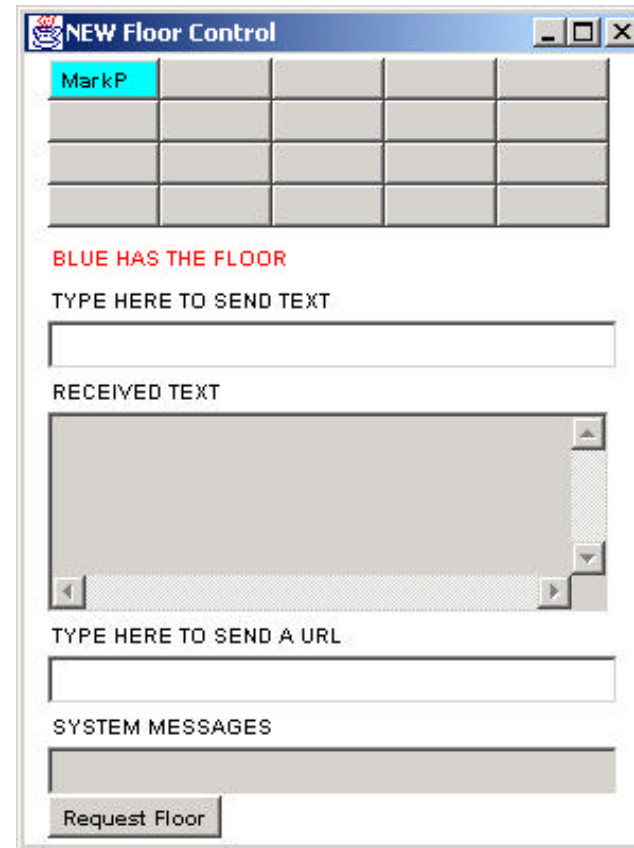
- Floor Control Client (application or applet)
 - one speaker at a time
 - modes: always, never, ask me
 - chat and URL forwarding
- Record and Playback Servers and Clients
 - timestamped UDP messages recorded to disk
 - run on local machine or elsewhere
 - controls are separate programs (application or applet)
- Transport Layer Multicaster
 - TCP/IP, UDP/IP, or UDP/IPmc
 - integrated with Floor Control and Record/Play

LOGIN...



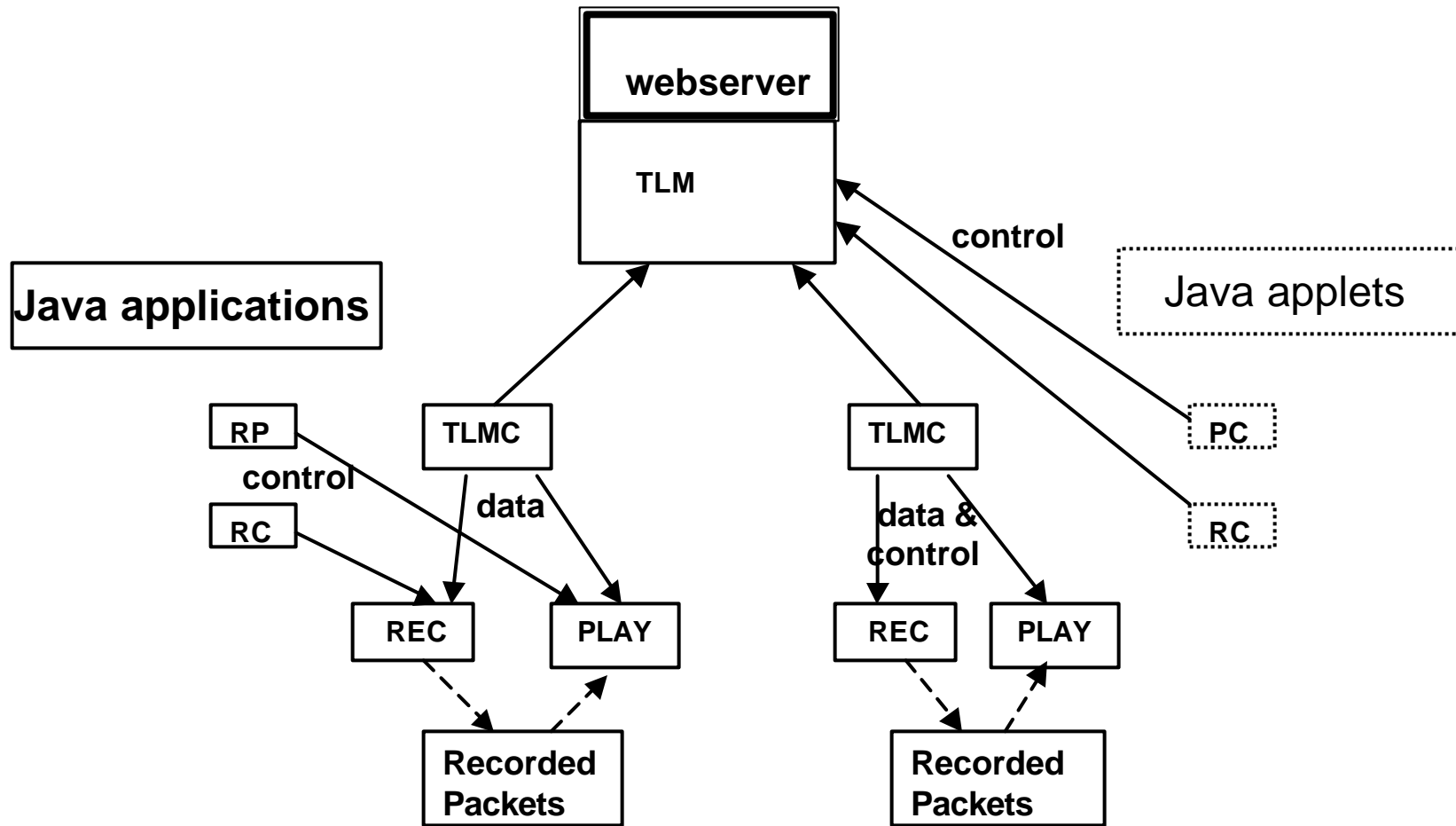
A screenshot of a Windows application window titled "NEW Floor Control". The window has a solid red background. It contains two labels: "Name:" and "Password:". Below each label is a light green rectangular input field. The window has standard Windows window controls (minimize, maximize, close) in the top right corner.

FLOOR CONTROL...



A screenshot of a Windows application window titled "NEW Floor Control". The window contains a grid of buttons at the top, with the first button labeled "MarkP" highlighted in cyan. Below the grid, the text "BLUE HAS THE FLOOR" is displayed in red. Underneath is a text input field with the label "TYPE HERE TO SEND TEXT". Below that is a scrollable text area labeled "RECEIVED TEXT". Further down is another text input field labeled "TYPE HERE TO SEND A URL". At the bottom, there is a scrollable area labeled "SYSTEM MESSAGES" and a button labeled "Request Floor". The window has standard Windows window controls in the top right corner.

TLM Record/Playback Connections



TLM Transport Layer Multicaster
 TLMC Transport Layer Multicaster Client
 (integrated with SpeakFreely)

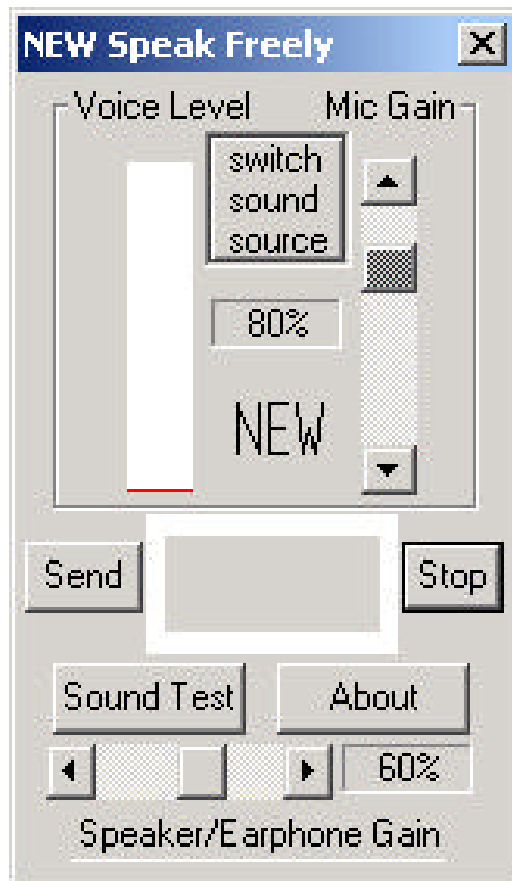
REC Record Server
 RC Record Control/Client
 PLAY PlayBack Server
 PC PlayBack Control/Client

TCP/IP \longrightarrow
 local disk \dashrightarrow

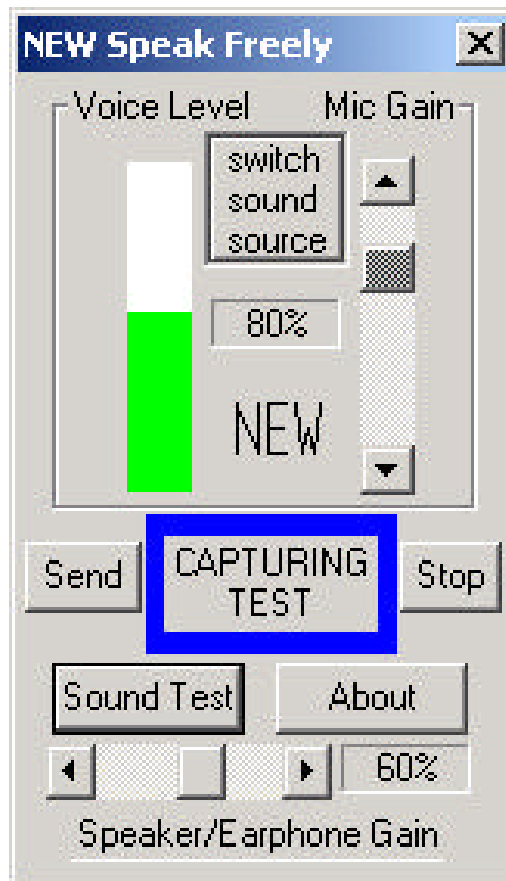
GMU Enhancement to Speak Freely Audio Peer

- Kept 100% of original function
- Added graphic user interface
 - send/stop buttons
 - highly visible status and level indicators
 - audio test built in (talker or listener)
 - microphone and speaker/earphone volume builtin
- Added audio mixer controls (including Videum camera mike option)
- Added TCP network interface
 - UDP to/from all tools by IP internal loopback 127.0.0.1
 - TCP connection to server tunnels all traffic
 - TCP connection to record/playback tunnels all traffic

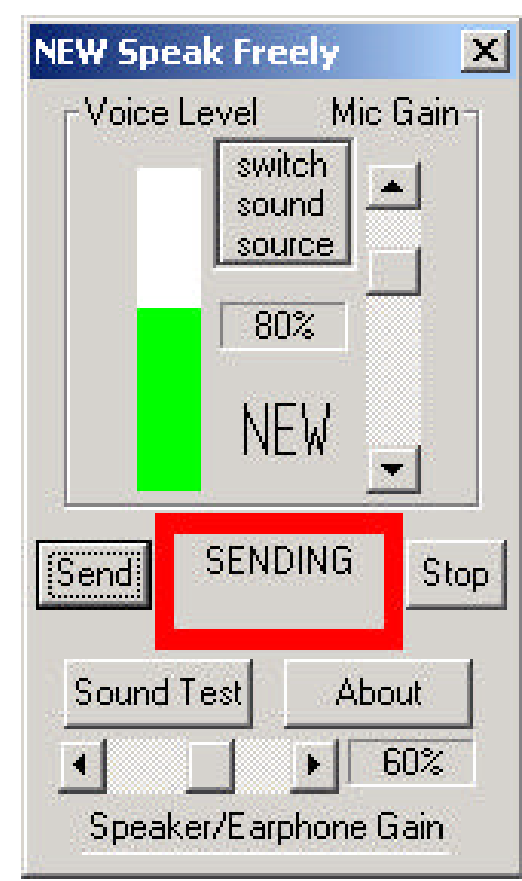
LISTENING...



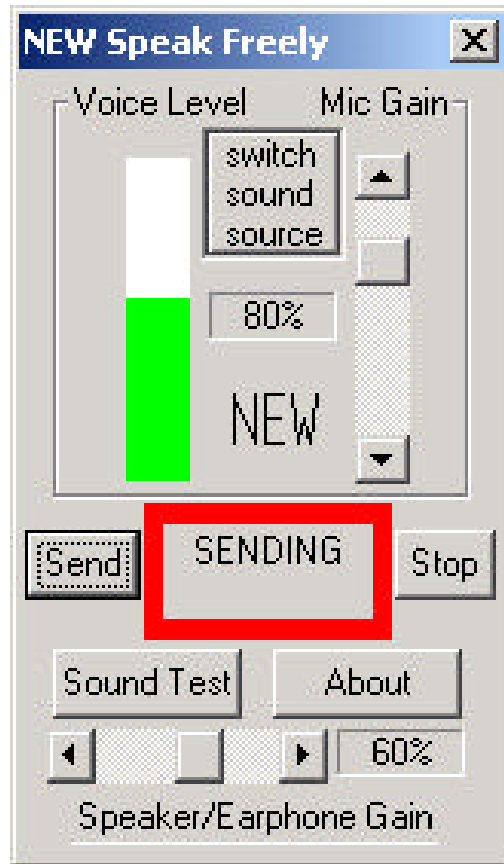
TESTING...



TALKING...



TALKING...



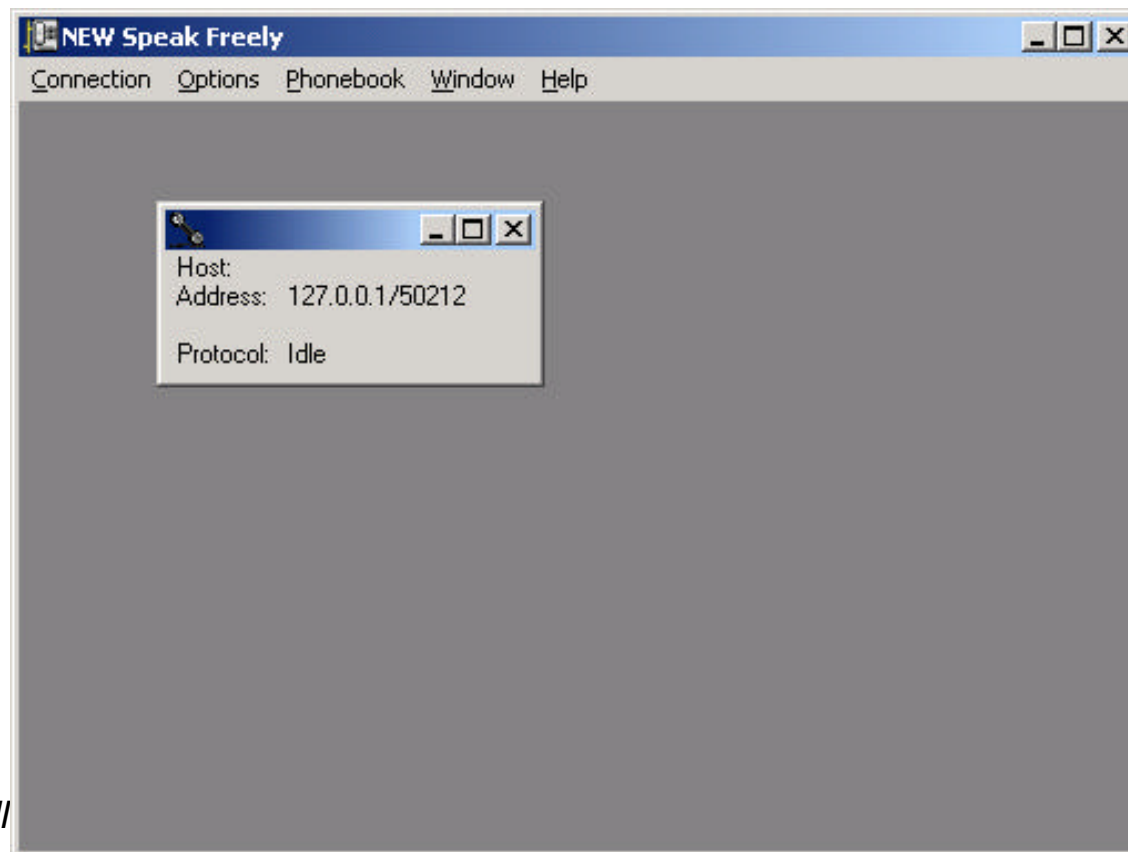
LISTENING...



Speak Freely Open Source

by John Walker

- 30 files with tens of thousands of lines in C
- over 100 files total counting included libraries
- typical Windows-style GUI interface



Speak Freely Internal Organization

- Main: control thread, message pump
- Init: reads config files, starts listening
- Frame: control for all options, audio listen interface, network receive function
- Connect: network send function, connection profiles, audio talk interface, sound files
- Dialog: popup boxes, including VoxMonitor modified extensively by NETLAB
- Many more: ANSWER, CRC, DESKEY, FACE, G711, LOOPBACK, LWL, ULAW, UTILITY...
- NETLAB added: Mixer (w ACK to UCL), Tunnel

More Details

see <http://netlab.gmu.edu/pubs>

Applicability of Internet Video in Distance Education For Engineering, *Proceedings of the IEEE Frontiers in Education Conference*, Reno, NV, October 2001, J. Mark Pullen

The Internet-Based Lecture: Converging Teaching and Technology, *ACM Special Interest Group on Computer Science Education (SIGCSE) Bulletin* Vol 32 No 3 pp 101-104, J Mark Pullen

ClassWise: Synchronous Internet Desktop Education, November 1999 special multimedia CDROM issue of *IEEE Transactions on Education*, J. Mark Pullen and Michael Benson