MIST/C: OPEN SOURCE SOFTWARE FOR HYBRID CLASSROOM AND ONLINE TEACHING

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Where we're coming from

Open Source Development Research

Our research addresses how to create the most effective, open source (and therefore robust and inexpensive) software to enable educators to exploit the synergy between:

- Synchronous and asynchronous course delivery
- Classroom and online delivery

History

- Long ago:
  - Pullen conceived and built advanced (for its time) network for military education/training
- After that:
  - After coming to Mason, began experimental online course delivery
  - Starting with the military network; later, Internet
- This grew into:
  - Research program develops open-source software
  - MSCS program online (soon, also MSSWE online)

Where All That Led

- Network EducationWare (NEW)
  - Open-source Internet teaching system
  - Built from open-source Internet tools
  - Used by several institutions
    - GMU CS Dept largest single user
    - And for conferencing in research environment
  - Audio/Graphics/Chat/Floor Control (Video optional)
  - Used for *simulteaching* : classroom + online

Which is Best?

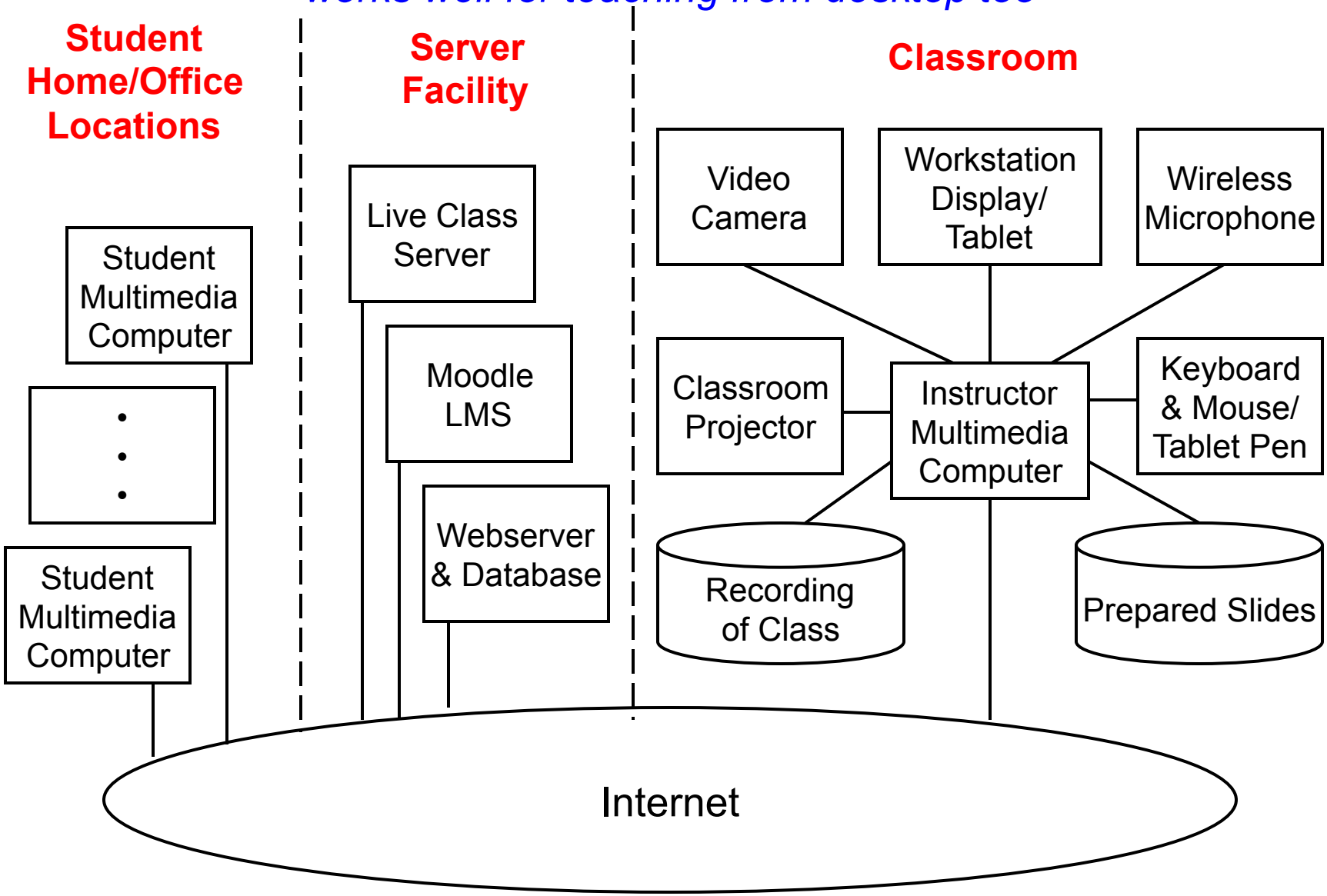
- Synchronous or asynchronous?
- Research shows students learn about as well either way
  - “no significant difference”
- So, “best” would mean a system that
  - Minimizes student time to learn the same amount of material (including commuting time)
  - Minimizes faculty time to present
  - Minimizes institutional cost to deliver

The *Simulteaching* Model

- Regional online course delivery
  - Avoids long travel time to attend class
- Students may attend in-person or online
  - or time-delayed via recording
- Classroom and online students have equal access to class and opportunity for interaction
- Low-cost approach
  - Nothing new to create; use existing slides
  - Teaching two groups at same time lowers costs
  - Video benefit marginal
    - Major cost is Internet connection
    - Provide if network is available
- Augment with website and asynchronous support

Simulteaching System

works well for teaching from desktop too




IASTED
WBE 2005
Best Software System Award
4th IASTED International Conference on
Web-Based Education
Grindelwald, Switzerland
February 21-23, 2005

Where we are now

Moodle Integrated Synchronous Teaching/Conferencing

MIST/C

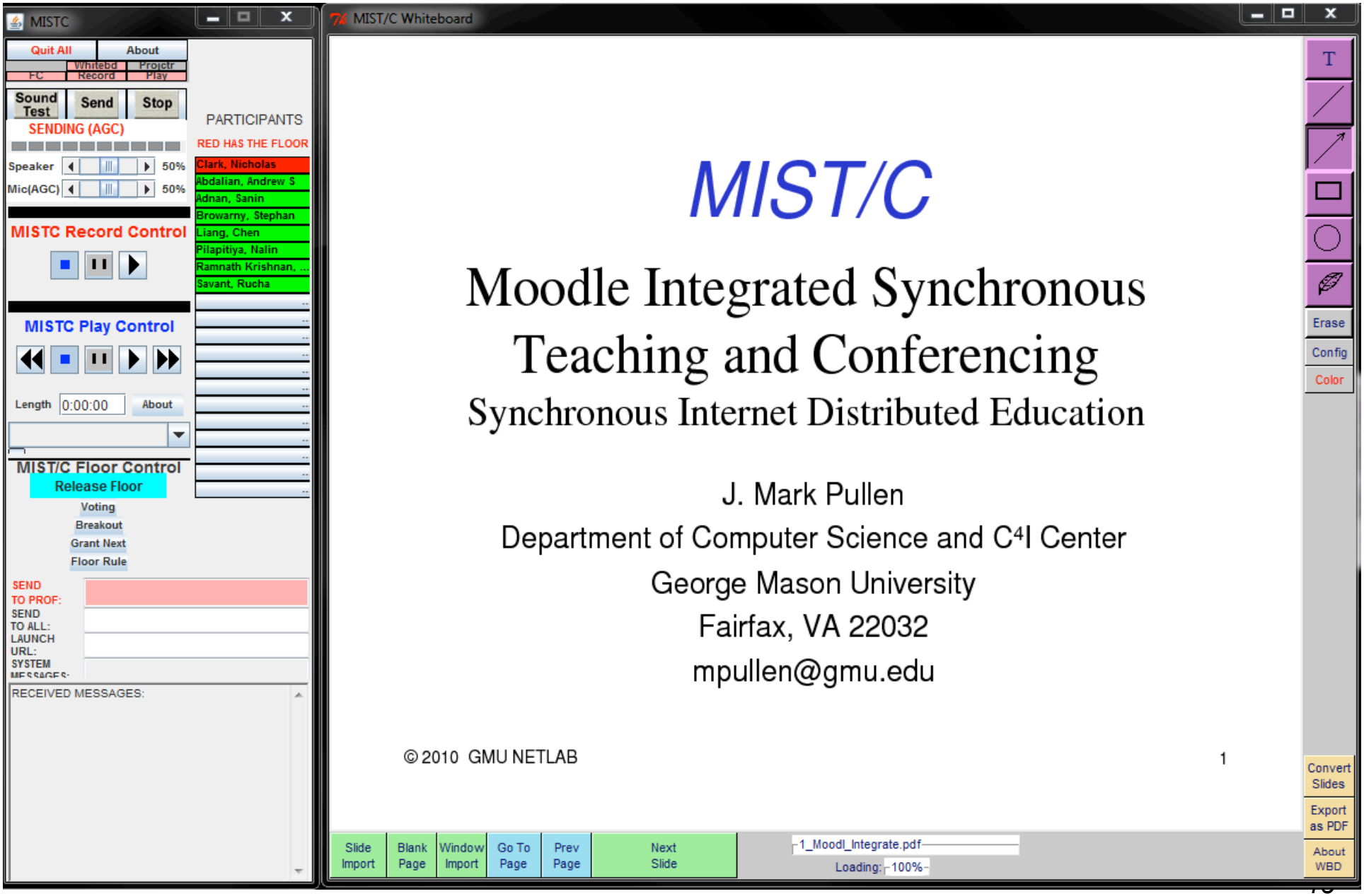
A project of the GMU Center of Excellence in Command, Control, Communications, Computing and Intelligence

(C^4I Center)

Purpose of MIST/C

- Provide a quality, easy to use, open-source tool for teaching and conferencing over the Internet, supporting:
  - Audio, graphics (slides and annotations), video, and text chat
  - Floor control, breakout rooms, and voting
  - Real-time interaction, recording of sessions, supporting simulteaching classroom and online students
- Built on Network EducationWare technology
- Using Moodle in place of custom portal
  - Combines best of synchronous and asynchronous

MISTC Client Interface



Features of MIST/C

- Multiplatform (Windows, Macintosh, Linux)
- Multimedia (Audio, Whiteboard, Video, Text)
- Second screen for local classroom projector
- Tablet / SmartBoard interface for handwriting & drawing
- Integrated, adaptive control window
- Slide authoring on any application due to PDF format
- Communicates via TCP for best access
  - Through NATs and Firewalls
  - Low data rate: dialup connection (without video)
- Server and client run on low-cost computers
- Free and open source (posted to SourceForge)
- Runs in low-cost hosting
  - Full CS & SWE program hosting $360/month

Goals of MIST/C Design

- Minimize complexity
  - Single control panel including audio
  - Powerful, multifunction whiteboard
  - Optional video
  - Very simple controls
- Keep all the good functions of NEW and add
  - Voting
  - Breakout rooms
  - Application launching
  - Extensible to additional capabilities
- Take full advantage of Moodle for security and file management
- Make installation of both client and server very simple

MIST/C and Moodle

- Moodle provides access control and file management for MIST/C
  - MIST/C has access to Moodle database
- Instructor saves slide files and recordings in Moodle for student access
- This allows all course materials to be available through Moodle at a single URL
- Or MIST/C in Blackboard via Moodle Building Block
- Easy-install package contains full server
  - System administrator loads a virtual module
  - Instructors can configure 24x7 MIST/C rooms

moodle

MOODLE ▸ S10 CS555-001/DL1

Switch

People

Participants

Activities

Assignments
Forums
MIST/C Rooms
Resources

Search Forums

Go

Advanced search

Administration

Turn editing on
Settings
Assign roles
Grades
Groups
Backup
Restore

Weekly outline

News forum

Attention Students! Follow the link below to connect to the class:

Syllabus
MISTC Client downloads
Whiteboard slides
Java Network Workbench
Project grading standards
CS 555 formulas you should know - final exam
Connect to class

25 January - 31 January

Lecture 1 slides
Lecture 1 recording
Lecture 1 for iPod

VSITE Synchronous Distance Education Requirements *vs* MIST/C Capabilities

Hardware/software

- *Client Operating System* : Windows XP/7, MacOS X and Linux
- *Browser* : All major
- *Communication* : Wired Internet and dial-up
- *Secure* : LDAP authentication
- *Limitations* : Seats & classes unlimited
- *Remote hosting by vendor*
- *Support and availability* : 24x7 real-time support
- *Audio* : Internet; no separate phone connection
- *Hardware support* : Wireless mouse/keyboard/mic; WebCam
- *Responsiveness* : Rapid response to inputs

VSITE Synchronous Distance Education Requirements *vs* MIST/C Capabilities

Usage

- *Customizations* : Accessible/expandable/enhanceable
- *Whiteboard* : Able to accept files in real-time
- *Authoring formats* : PowerPoint, PDF, Keynote, OpenOffice
  - All participants able to annotate slides
- *Video* : common computer formats (.mpg, .avi, .mov); camera
- *Recording of sessions* : automatic on server; including chat
  - Able to render as mpeg for podcasting
- *Interaction* : testing/quizzing; polling/hand-raising; voice + chat
- *Student tracking* : login status; participation statistics
- *Configurable to screen* : by the user; application window capture

MISTC/ meets the requirements and more!

MIST/C Extended Capabilities

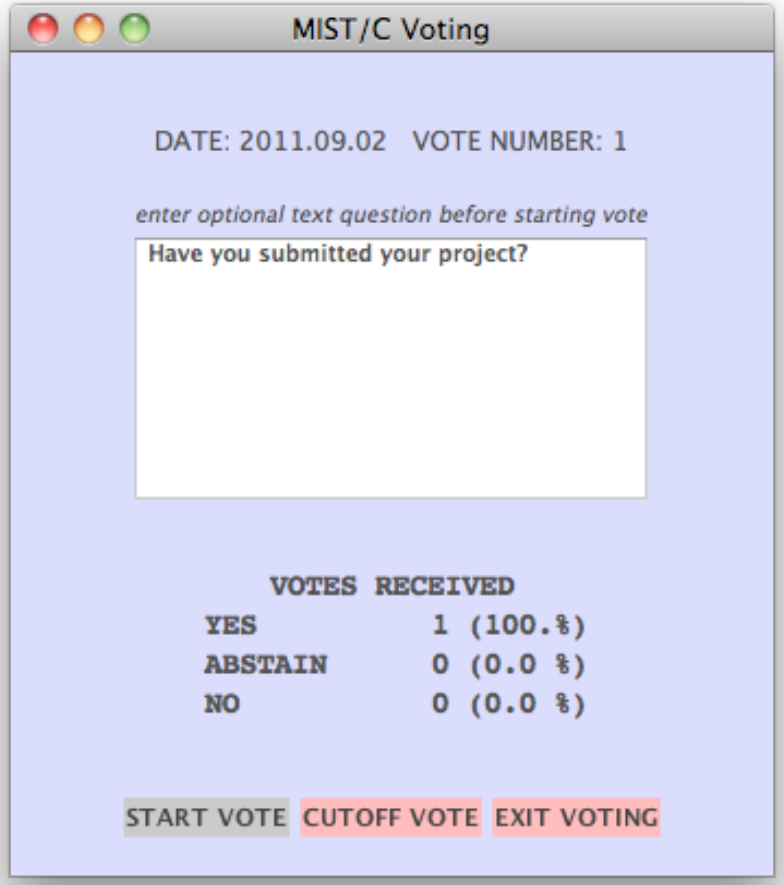
- Added whiteboard functions
- Voting (“hand-raising”)
- Breakout rooms
- Application launching
- User interface improvements
- Auto-reconnect
- Server-side recording
- Link in new tools: *e.g.* Virtual World Viewer

MIST/C Extended Capabilities

- New whiteboard functions
  - Added power to one of most valuable components
  - Usable by instructors and students
  - Supports one-page PDF slides with annotation
  - New data formats: JPEG, PNG, multi-page PDF
  - Second whiteboard for full screen in classroom
    - Feature unique to MIST/C
  - Import of other windows from user's computer
    - With option to repeat automatically at 5 to 10 second intervals
    - Allows instructor share output of any application

MIST/C Extended Capabilities

- Voting ("hand-raising")
  - Panel pops up for every participant
  - Yes/Abstain/No votes tallied and logged
  - Optional text description of the proposition being voted

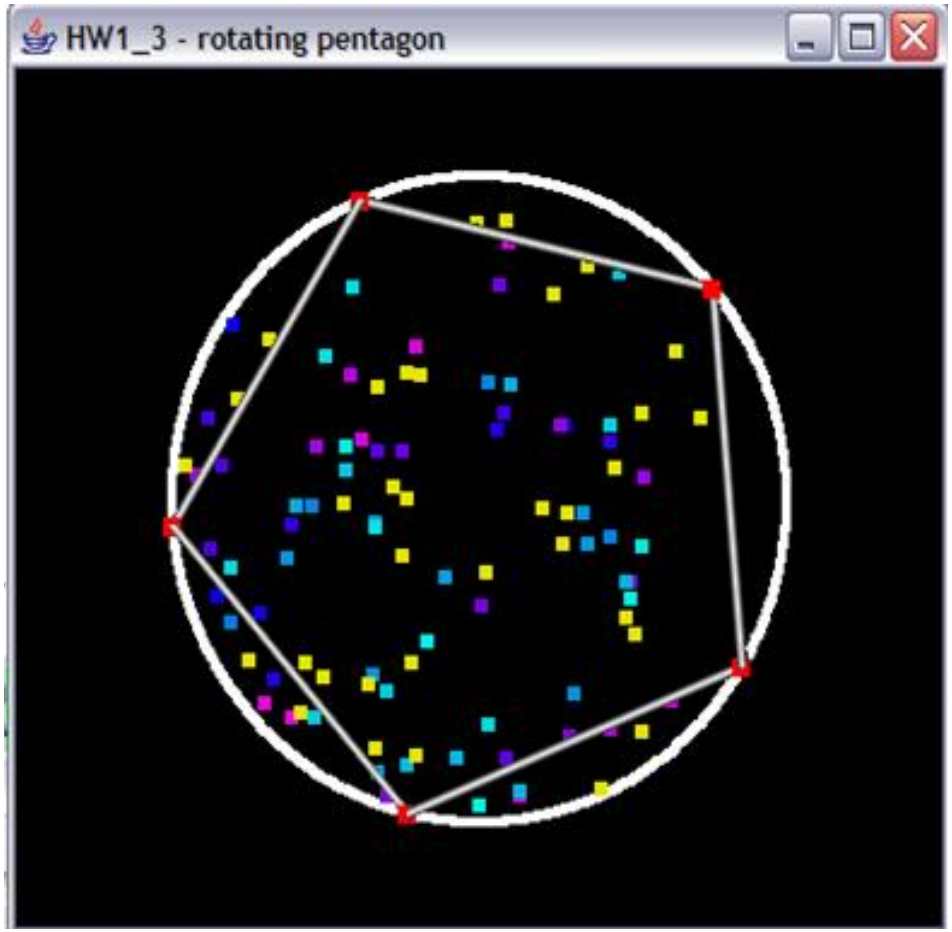


MIST/C Extended Capabilities

- Breakout rooms
  - Instructor assigns students to groups
  - In Breakout mode, each group forms a small class
  - Can use all MIST/C communication tool
  - Instructor can make "PA" announcements to all (send-only)
  - Or join a group and interact

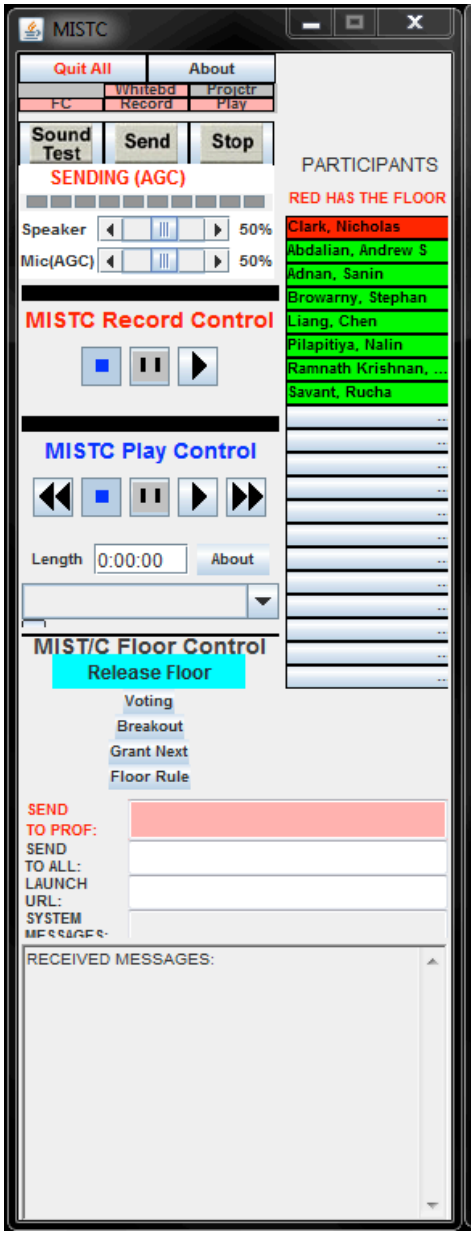
MIST/C Extended Capabilities

- Application launching
  - Instructor starts the same app on all desktops
  - Data file is downloaded in background
  - Useful for apps with rapid graphic motion (video etc)



MIST/C Extended Capabilities

- User interface improvements
  - Integrated control/chat avoids proliferation of windows
  - Includes floor control with full names, alphabetized
  - Show/hide of record and playback control (separately) under user control
    - Also can be preconfigured
  - Turn floor control, teaching whiteboard and projector whiteboard on/off
- Instructors configure for class with a few clicks



MIST/C Extended Capabilities

- Auto-reconnect
  - Network disconnects are inevitable
  - Must avoid having this distract instructor
  - MIST/C automatically attempts reconnect
    - Session continues without interrupting recording
    - Classroom recording insures session is available to online students later
  - Also supports standalone recording if completely offline

MIST/C Extended Capabilities

- Server-side recording
  - Classroom recording with pause gives best flexibility to instructors
  - Also insures a recording when network breaks
  - But instructors are human; will forget to start it
  - Serverside recording runs automatically during whole class session as a backup
  - And can be retrieved by instructor through the MIST/C control window

Teaching with MIST/C

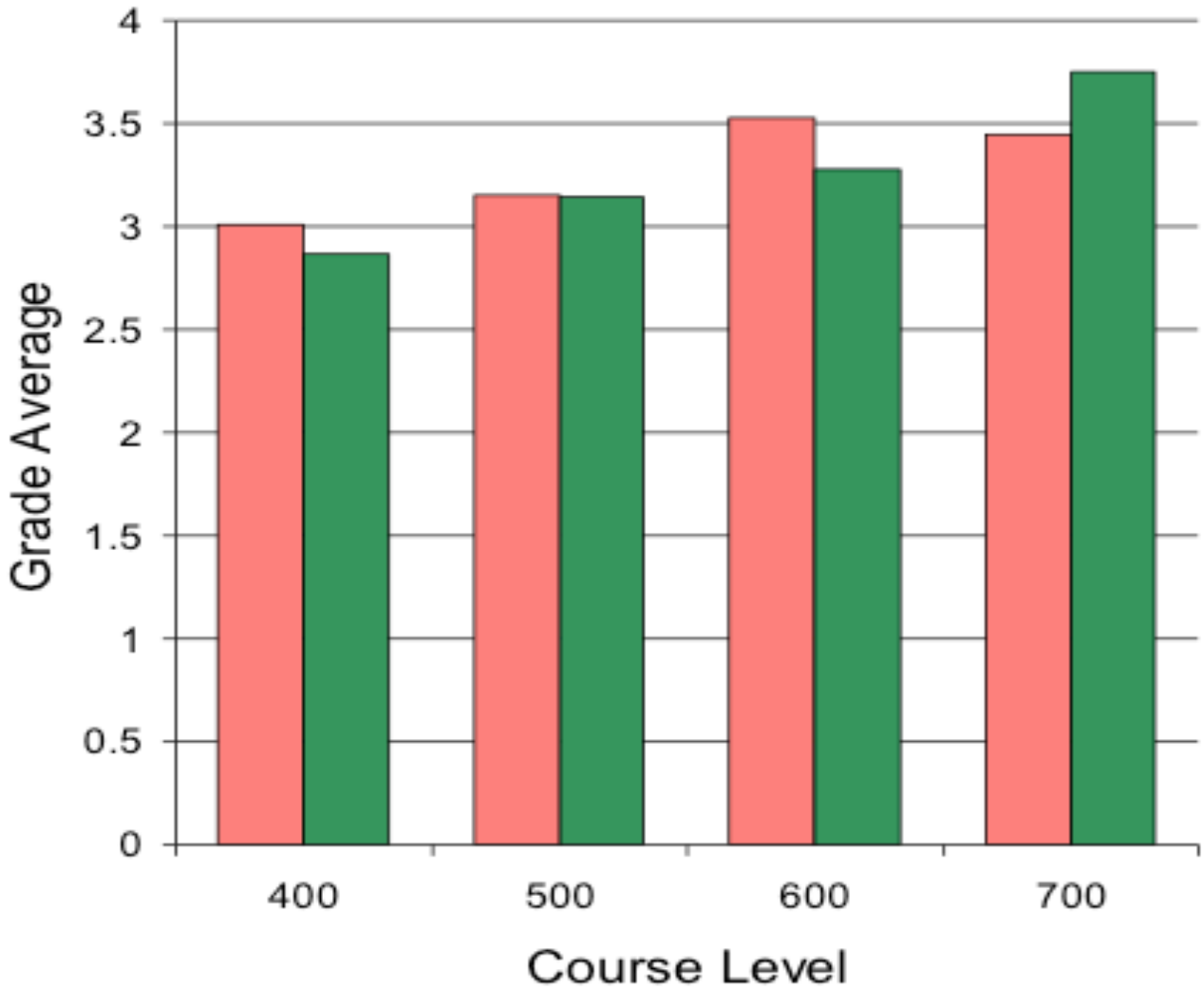
- Initial shake-down was conducted by Pullen's Computer Networking class
  - 27 MSCS students
  - About half attended remotely
    - Some off and on
  - Gave them option to use MIST/C to produce report for a project
    - 17 of them did this, all successfully
    - Mostly positive feedback
    - Helped to identify user documentation problem
  - Discovered Moodle made integrating content, projects and homework work better
- Next semester, MIST/C took over from NEW
  - Supported 12 online courses with minimal problems

MIST/C in a Degree Program

- GMU has offered the Master of Science in Computer Science online since 2004
  - Identical with classroom version
  - Student mix delivery methods at will
  - Faculty tailor blended delivery to their subject and individual style
  - Number of courses online continues to grow
- "No significant difference" between online and classroom outcomes
  - Students telecommute to optimize schedule
  - And attend remotely or time-shifted when traveling

No Significant Difference in Outcome

But student time spent commuting can be significantly different!



Future Work

- Scale up MIST/C to hundreds of courses
  - By running it in cloud computing
  - Using dynamic load balancing
  - Prototyped this and found one server will support 200 students
  - Can be used to support any number of courses
- More enhancements to client
  - MP3 option for iPhone/iPod playback
  - Separate chat room for closed-captioning
  - Student note-taking recorder option

Summary/Conclusions

- Simulteaching with synchronous plus asynchronous delivery minimizes costs and additional faculty time
- **MIST/C** supports it in free, easy-to-use software that is integrated with Moodle
  - See http://netlab.gmu.edu/MISTC to download
- Online delivery increases accessibility of education
- For best effect, combine with Moodle asynchronous
- GMU has used simulteaching to extend its MSCS and SWE online to reach more regional students
- Results are highly promising
  - Enrollment, grades, student evaluations all good

GMU C4I Center
Networking and Simulation Laboratory

MIST/C

For more details, see:

http://netlab.gmu.edu/MISTC

Backup Slides

MIST/C Audio

- Quality audio over the open Internet
- Half duplex model (one sender at a time) avoids babble and acoustic feedback
- Audio packets have highest priority in both client and server
- Control interface has volume bar and level controls integrated with host computer

MIST/C Whiteboard

- Native input formats PDF, JPG, PNG, TXT
- Autosizes to screen and autoscales images
- Captures single or repeating images of screen
- Buffers annotations for redisplay
- Variety of annotation tools, colors, sizes
- Application sharing via screen capture
- Works particularly well with tablet input
- Second whiteboard supports class projector

MIST/C Video

- 512x382 pixels
  - about the same as US analog TV
- Adjustable to fast scan but normally used at two frames per second
- Works well with inexpensive webcam
- Not used by all instructors
  - Many find voice and graphics is sufficient

MIST/C Floor Control & Text Chat

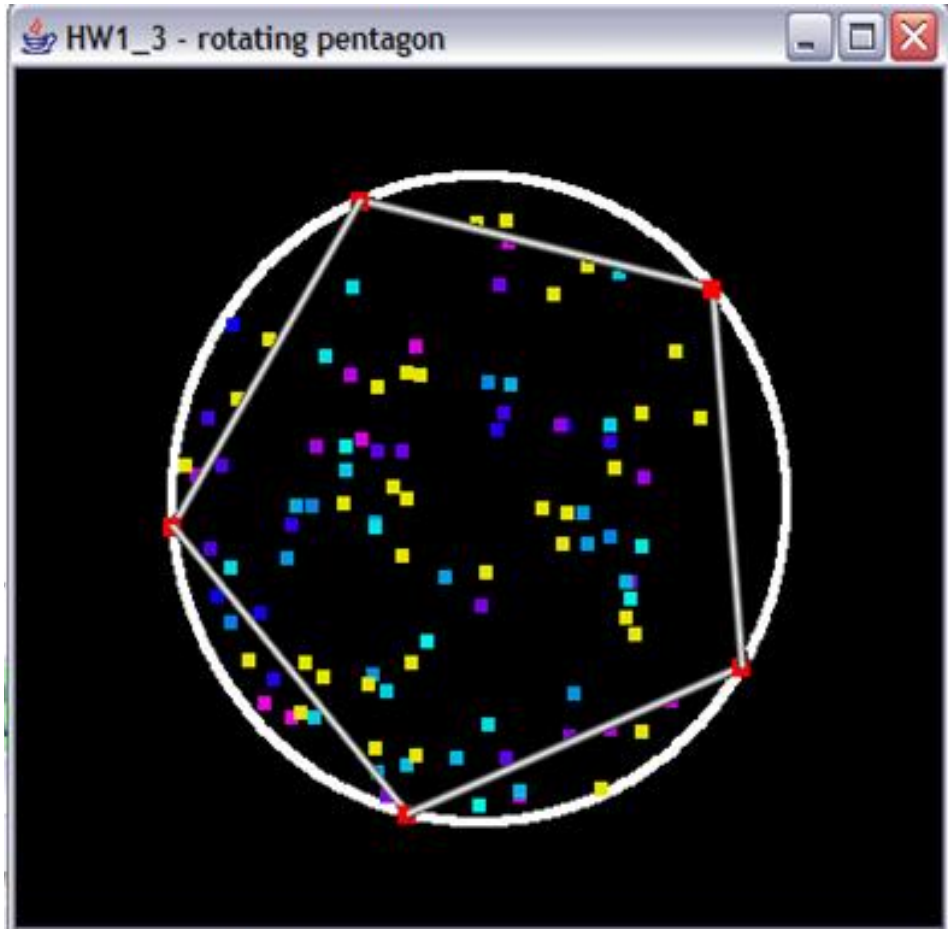
- Displays names and status of participants
- Floor may be controlled or open to all users
- Participants may chat among themselves or send private notes/questions to "PROF"
- Includes ability to launch applications (including Web browser) on all participants' screens
- Always logged by server; record/playback optional
- Also supports voting, breakout rooms, and application launching

MIST/C Record & Playback

- Controlled by simple “videotape” interface
- Recorder captures outgoing stream
- Player reproduces original input on audio/ whiteboard/video*/floor control*
- Can run both at the same time
  - Play previous recordings in class
  - Edit recordings to add material

* recording of video & floor control optional

Application Launching Example



Why Moodle?

- Open source
  - We'll never be locked away from the codebase
- Developer friendly
  - Analysis showed interface module much easier to write than for Blackboard
- User friendly
  - Everybody we talk to who uses it, likes it!
- Increasing popularity
  - For example, Moodle is Colloquy360's choice
  - Our workshop at DTL'10 grew over 3X when we developed MIST/C to work with Moodle

Scalability of MIST/C

GMU CS Operating Costs

Using **MISTC** with existing electronic classroom supporting up to 16 courses (two MS programs)

- One Linux server
- Small fraction (<10%) of a system administrator's time
- Two Graduate student Information Technology Assistants
  - check equipment daily
  - monitor outgoing session quality
  - post recordings, etc.
- Network cost
  - if usage grows beyond existing capacity

GMU MSCS & SWE Online Courses

http://cs.gmu.edu/programs/distance/

Course Number	Course Name	Offered at Least
CS 540	Language Processors	Annually
CS 555	Computer Comms and Networking	Annually
CS 571	Operating Systems	Annually
CS 580	Introduction to Artificial Intelligence	Annually
CS 583	Analysis of Algorithms	Annually
CS 631	Object-Oriented Design Patterns	Annually
CS 635	Foundations of Parallel Computation	Biannually
CS 640	Advanced Compilers	Biannually
CS 652	Computer Graphics	Annually
CS 658	Networked Virtual Environments	Biannually
CS 672	Computer System Perf Evaluation	Annually
CS 706	Concurrent Software Systems	Biannually
CS 755	Advanced Computer Networks	Biannually
CS 756	Performance Analysis of Computer Networks	Biannually
SWE 619	Software Construction	Each Semester
SWE 620	Software Requirements Analysis	Each Semester
SWE 621	Software Architecture & Modeling	Each Semester
SWE 625	Software Project Management	Each Semester

Operational Concerns

- Economy of scale
  - Our experience indicates the hosting we are using will support 2 to 3 times the course load we have now:
    - 20 to 30 courses per machine
    - Limit: around 100 students on a server at once
  - Beyond that, just buy more hosting: virtually unlimited scaling by using the Web
- Reliability: other than very short Internet outages (less than one minute) we’ve had no problems in the year since placing NEW in hosting
- Support: we have a local business partner (VSITE graduate) who would like to provide commercial help desk and server operations on a sliding scale
  - With MIST/C, no software cost !