

Music from the Mountains: Providing Live Music Arts Education Using Internet2

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Abstract/Introduction:

Saint Francis University is in the process of expanding the reach of live fine arts, humanities and music education to remote audiences via Internet2 video teleconferencing. Beginning in Spring 2006, Saint Francis University provided live interactive lectures to a national and worldwide audience free of charge via the Internet2 Commons. The impact of these sessions was immediately apparent; with very little time to promote them (two weeks) and a very small budget, the initial sessions each garnered audiences from 60 to 80 participants. Subsequent programs have attracted as many as 600 simultaneous participants. Requests for these music sessions have come from areas as remote as Pakistan and Australia. Sessions presented included instruction and lectures on the didgeridoo, the tabla, the Ngomo drums, Native American culture, African culture, music performance anxiety, and basic song writing.

This paper will detail the technical steps taken by Saint Francis University, a small rural private institution, to build an online music education series on Internet2. With a heavy emphasis on lessons learned, Saint Francis University staff will reveal their “common sense” methods of producing high-quality music education via compressed video, as well as plans for future program expansion.

Background:

The Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA):

This project was conceived with and supported by Saint Francis University’s Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA). CERMUSA, a government-funded telehealth and distance learning applied research initiative, has been experimenting with remote video communications in education since 1994. The remote music and humanities project had its roots in previous and ongoing CERMUSA research projects such as the Wireless Campus, Rural GigaPoP, Portable and Mobile Classroom (PortMoC), and Mobile Communication Platform (MCP). In the past, CERMUSA maximized content for dial-up speeds, due to the telecommunications limitations of a rural audience. This motif usually limited online content to basic applications, such as text chat and less graphically-intense web pages. Interactive video

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was limited to costly toll services such as T-1 and ISDN lines. The proliferation of affordable rural broadband and Internet2 access within the educational community over recent years has enabled CERMUSA to experiment with more robust types of distance learning, particularly interactive video.

Internet2:

Internet2 is a research consortium of schools, government departments, and corporations that runs on a high-speed fiber data infrastructure known as the Abilene Network. This high-speed network crosses the country and interfaces with other international high-speed education networks.

Research and education opportunities are present within Internet2, including virtual cadaver dissection, foreign language education, music education and distributed supercomputing. Internet2 is being utilized in colleges/universities and some school districts in urban/suburban areas for these educational opportunities. Nothing has been done for music education in rural areas using Internet2. CERMUSA addressed this need by establishing an “aggregation point” model for these rural schools. The aggregation point model was established in the following way: CERMUSA receives its Internet2 service from MAGPI (see below) and distributes the Internet2 service to local schools in the central part of Pennsylvania. Currently, CERMUSA provides service to 40 of these rural schools. CERMUSA joined Internet2 in 2003 and has performed research in a variety of areas, most notably with patient simulation at Naval Health Research Center - San Diego. CERMUSA’s research efforts have also been publicly discussed and disseminated via academic gatherings and publications including Internet2 Annual Member conferences.

CERMUSA connects to Internet2 via the Metropolitan Area GigaPoP Philadelphia (MAGPI) at the University of Pennsylvania, Philadelphia, PA. MAGPI is a regional GigaPoP (key network interconnection point) for Internet2, connecting sites in Pennsylvania, Delaware, and New Jersey. In addition to the Internet2 connectivity, MAGPI provides content services and promotion of Internet2 events among their members.

The Internet2 Commons is a resource to Internet2 provided by the Ohio State University. The Internet2 Commons provides a location for groups from around the country and the world to meet utilizing video teleconferencing. The video teleconferences from the Saint Francis University Online Music program were housed on the commons. Additionally, the commons offered extensive support for network and video teleconference administration.

Saint Francis University Fine Arts Department:

The Saint Francis University (SFU) Fine Arts Program spans a large part of the University’s history. SFU Fine Arts, which includes music, theater, and visual arts, is alive and well in the 21st century, with steadily increasing student involvement and more activities and classes on campus. Much of this continued momentum can be attributed to the new initiatives of existing and new arts faculty.

One of the catalysts for this change was the addition to the faculty of Jim Donovan. Mr. Donovan is best known as the drummer for the Grammy-nominated rock band Rusted Root. An accomplished and published musician in his own right, Mr. Donovan had also been teaching semi-

nars for the university over the past 4 years, prior to his appointment to faculty in the SFU Arts program during Spring 2006.

Creation of the SFU Online Music Program:

Conceptual discussions for the SFU online music program began in February of 2006. SFU President Fr. Gabriel Zeis personally introduced Jim to CERMUSA Director Jay Roberts in the hopes of generating interest in collaborating. CERMUSA immediately recognized the potential in including a seasoned and technology-friendly musician as part of SFU's Internet2 programs.

Mr. Donovan's initial vision was to extend the reach of traveling performers and artists visiting SFU to a worldwide audience. A combined video production and IT team from CERMUSA met with Jim Donovan to go over production technical needs. The group agreed that the concept was sound and worthy of preliminary testing.

Methods and Materials:

As of March 2006, Jim Donovan already had performers scheduled in the spring and fall semesters. Fortunately, all of them were willing to participate in the Internet2 music program. Instructional design for the students was handled by Jim Donovan and the lecturers. Each of the 6 programs followed a similar pattern:

- Lecture
- Performance
- Question and answer from the remote sites

The following is a list of the performances in 2006-2007:

- "The Didgeridoo: Exploring the Dreamtime" with Jim Gagnon, a combined lecture/live performance featuring aboriginal Australian instruments.
- "The Universe of Song" with Paul Purple, a "do it yourself" songwriting workshop.
- "Ngomo: A Conversation about Music, Dance, and Life in Central Africa" with Elie Kihonia, a discussion and performance about the Ngomo drum and its importance in the culture of Central Africa.
- "The Tabla: An Introduction to the Classical Drumming of North India" with Jim DiSpirito, a discussion about the tabla drum and its presence in the culture of northern India.
- "Rainbow Eagle: An interactive presentation of Native American teachings through song, stories and multi-media," with Rainbow Eagle.
- "400,000 people. Carlos Santana and Me" with Jim Donovan, a recount of the proper way to do a drum solo and performance.

Technical Background:

Following initial discussions, CERMUSA performed extensive experimentation with reproducing live audio via VTC. CERMUSA leveraged partnerships with both the Cleveland Institute of Music (CIM) and the New World Symphony, both innovators in music broadcast over Internet2, to act as remote evaluators for our progress. The team worked with Jim to try a series of microphones, VTC units and audio settings in our Distance Learning Prototype Lab (DLPL) and relied

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on the trained ears of our remote partners to tell us when we “got it right.” Based on the early successes in these tests, CERMUSA scheduled an inaugural online music session for April 3, 2006.

CERMUSA also performed network quality-control activities in order to deal with a problematic network transport services provider. This provider had experienced a string of service outages in the weeks leading up to this performance, potentially jeopardizing all CERMUSA Internet2 activities. CERMUSA enlisted network administrator Robert Dillon to ensure that our local network was interfacing correctly with our transport services provider, and with MAGPI, our Internet2 service provider.

Overcoming Technology Challenges:

CERMUSA Production and IT staffs worked with Mr. Donovan to devise a basic testing methodology to determine the best practices for transmitting live music performance via videoconferencing. As mentioned earlier, CERMUSA enlisted the help of the Cleveland Institute of Music (CIM) and the New World Symphony, as remote evaluators.

CERMUSA engaged Mr. Donovan on a two-phase testing methodology:

- Acclimation to compressed audio
- Use of compressed audio for live music reproduction

Acclimation to Compressed Audio:

Before coming to SFU, Mr. Donovan had never participated in VTC activities or transmitted live music via compressed audio. Because of some of the characteristics of compressed audio, the CERMUSA team decided that Mr. Donovan should be acclimated to these limitations before deciding to move forward.

VTC equipment is designed to compress audio signals (i.e. “squash” high and low frequencies and volume levels) to successfully reproduce remote conversations. As such, standard VTC audio inputs and microphones are optimized for the frequency range of human speech. These audio components were never designed to transmit guitars, drums, or even singing. Additionally, most existing VTC systems, including those owned by CERMUSA, are designed to transmit mono audio and are incapable of generating stereo or surround sound audio signals.

CERMUSA staff contacted the New World Symphony and provided them with copies of several of Mr. Donovan’s songs. Mr. Donovan then listened to the songs over a live VTC to judge the sonic reproduction of these recorded pieces. Based on his knowledge of his own material, Mr. Donovan felt that the transmission, although compressed, still elicited the key sounds and dynamics of these songs. Based on Mr. Donovan’s decision, the team moved forward to live music reproduction.

Use of Compressed Audio for Live Music Reproduction:

Maintaining audio integrity between the sending and receiving sites was the team’s largest concern. In a traditional classroom music experience, both instructor and student will experience the same acoustic response from a musical instrument. Subtleties, such as a strike on a hand drum

rim (treble tone) versus the center (bass) tone, are immediately apparent. These subtleties and other audio details can easily be lost over VTC due to audio compression.

CERMUSA called upon our colleagues at CIM to act as a receive site for our audio tweaking sessions. We were fortunate to make contact with Adam Philips, CIM Manager of Distance Learning Programs. In addition to administering CIM's online presence, Mr. Philips is also a trained drummer with strong experience in reproducing live music via compressed audio.

CERMUSA decided on a two-tiered approach for testing. Operating in the DLPL, a VTC-enabled television studio, the video production team attached video and audio feeds from the control room into several video teleconferencing units. Our goal was to identify the right combination of VTC unit and microphone arrays to produce the best possible audio reproduction. CERMUSA technical and production staff selected drums as a first test instrument, due to the dynamically-challenging acoustic properties (lots of high and low frequencies).

Early tests with standard room microphones proved unsatisfying and unsuccessful in all video codecs. Our receive site reported that the audio ranged from “flat” to “garbled.” It was immediately apparent that more specialized microphones would be required. Despite the less than favorable initial results, the Tandberg 6000 codec produced the most desirable transmit audio of all the units tested.

Our team was fortunate in that a member of our production crew was a professional live sound engineer with a strong background in percussion. Based on his recommendations, a multiple-microphone setup was specified. The microphones used were Audio Technica ProAT37R condenser microphones and Shure Beta52A dynamic microphones, all routed to and controlled by a Mackie 8 input audio mixer board.

CERMUSA tested several microphones and configurations with the Tandberg 6000 codec connecting to CIM at connections speeds ranging from 128 to 768 Kbps. The instruments in the test were a djembe hand drum, shown in figure 1, and a pair of didgeridoos that Jim Donovan and James Gerraughty had in their possession.



Figure 1

During testing, CERMUSA’s network was monitored to ensure there were no packet collisions or other network anomalies that would interfere with the video teleconference.

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The results were:

- Mr. Donovan and MR. Philips both felt the sound of compressed audio was still “flat,” but emphasized the key elements. Moreover, it was adequate for educational purposes.
- The receive site reported that all key elements of the instruments selected could be easily identified.
- The sub-mixing on the Mackie board and microphone placement was key to having good audio for the far end.
- The Tandberg 6000 had the best audio reproduction. Other VTC units tested were a Polycom Viewstation FX and a LifeSize HD system.

Thus, the solution to this challenge was to use proper microphones and placement and to perform adequate test calls prior to an event. Despite the ultimate simplicity of these solutions, this level of audio production was new ground to CERMUSA. Our production and IT personnel documented the results in order to apply them to all the music classes that were offered via VTC.

Results:

Based on the success of this testing, SFU offered its first live online music event, “**Exploring the Dreamtime with Jim Gagnon**,” in April 2006. An audience of 12 sites, including a location in Australia, attended the session. A second session, “**The Universe of Song**,” was offered several weeks later with similar attendance. Both the SFU and CERMUSA administrations were pleased with the progress made by the joint Fine Arts/CERMUSA team, and funding was allocated by the SFU VP for Academic Affairs to continue project work into the fall of 2006 and spring of 2007.

Other Difficulties/Lessons Learned:

Far end participation:

A constant challenge encountered was that some of the remote participants did not have much experience with VTC sessions and related support. Fortunately, CERMUSA had a good support network through MAGPI and the Internet2 Commons that mitigated some of technical issues at the far sites. The most common issues encountered included familiarity with global dialing schemes (GDS) and use of microphone mute controls.

Instructor experience with VTCs:

Although Jim had not participated in VTC activities prior to this project, up-front training with CERMUSA staff was very effective. Jim was then able to act as a trainer for visiting artists participating in our online sessions.

Internet2 vs. Commodity Internet:

Several sites over the course of the six classes contacted CERMUSA to see if they could participate over commodity Internet. Once again, the Internet2 Commons was helpful in allowing commodity Internet access. Where this accommodation was not possible, CERMUSA often included other sites via our own MCU. Technical observations were that sites connected over commodity Internet had a higher rate of audio synchronization issues (lips weren't synchronized, video cut-outs), even though they were connected at the same speed of 512 Kbps. This was indicative of the higher rate of packet collisions on commodity Internet.

CERMUSA is currently exploring the option of limiting specific performances to Internet2 only to ensure the overall audio/video quality of each event. Non-Internet2-enabled sites will have the option of viewing a video stream of the event courtesy of MAGPI.

Quality of receive sites:

Just like a disruptive pupil can distract the teacher and the other students, remote sites that did not mute their microphones or did not know how to do so were very distracting to the music classes. The solution that was employed was to constantly remind far sites about mic muting during the test calls and the actual performance.

Sub bridging – multiple school bridging into MCUs:

Some schools could not connect to the Internet2 Commons using their own systems and were required to dial via a centralized Multipoint Control Unit (MCU). MCUs allow multiple sites to connect to one point that will then connect to a video conference. This is usually done within networks to economize on Internet Protocol (IP) addresses. Unfortunately, most MCUs cannot dial the GDS number that the Commons required. There were two solutions to this issue: Either have the Commons set up a direct-dial IP address, or make the far-end MCU “think” it's dialing an IP address through GDS spoofing. GDS spoofing was a solution given to us by Megan Troyer of the Internet2 Commons.

Unanticipated presenter requirements:

Sometimes presenters arrived in the studio with extra instruments that had not been tested or changes to their presentation materials. Unfortunately, we were not always able to accommodate the performer. The solution to this challenge was to establish early-on the needs of the performer and hold them to it.

Equipment/network failures:

During the course of the classes, we had several pieces of equipment break down. The most notable were video input failures on two separate VTC units. The solution was to always have a backup VTC unit in case one fails. Fortunately for CERMUSA, the DLPL was designed with built-in VTC redundancy.

Several of the early online sessions were marred by network errors at CERMUSA. These problems were resolved via a change in network carrier and replacement of a failing copper to fiber converter.

Future plans:

CERMUSA was astonished to see the popularity of the SFU online music sessions grow with each subsequent offering. By the last online performance, “400,000 people, Carlos Santana, and Me,” CERMUSA had to put attendance caps on sites participating. It was exciting to see something grow so fast inside of a year’s time. With this success capping a year of rapid progress, CERMUSA is in the process of making future growth plans as of this writing.

Future growth plans include:

- Local support from Saint Francis University
- Grant applications to federal agencies
- Possible fee structure to create a self-sustaining operation
- Research into the educational efficacy of the programs

Jim Donovan is also in talks with Saint Francis University to increase funding for the music education classes. Both the Vice President for Academic Affairs Dr. Wayne Powell and the President of the university Fr. Gabriel Zies were impressed with the popularity of these courses. As of this writing, funding was secured for Fall of 2007.

In addition to the local support from Saint Francis University, Kent Tonkin and Jim Donovan applied for a grant from the National Endowment for the Humanities to further the program and purchase equipment for a digital music/education archive that would be housed at Saint Francis University. This archive would be accessible for students and teachers worldwide.

Research into other online programs, including music programs, indicates that many institutions charge a per site/per session fee for participating. CERMUSA is in process of conducting an on-going cost/benefit analysis to determine a “break-even” cost. At this point, CERMUSA and SFU are hoping to offset part, if not all of, the costs of operation in order to create a self-sustaining program. As these sessions continue and our knowledge base increases, our team hopes to further build the SFU online music program via competitive grants and other outside sources of funding.

Finally, as part of the CERMUSA distance education mission, research would be conducted in order to find out how much the participants are learning. Educational research such as this could be critical to schools and colleges in justifying distance education programs.

In conclusion, the Saint Francis University Online Music Program was a great way to determine our strengths and fix our weaknesses with regards to video production, video teleconferencing, and network administration. The lessons learned with the audio transmission, remote sites interaction, and network monitoring will make the SFU online music program into a smooth-running operation that can be sustained and provide a benefit to the educational and musical community at large.

References

<http://www.cim.edu/dlPrograms.php>

<http://www.aahom.org/pdf/FieldTrips.pdf>

<http://www.msmnyc.edu/special/distancelearning/k12comm/>

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