44th International Conference
Audio Networking

San Diego, November 18–20, 2011

CONFERENCE REPORT

Nathan Brock opens the 44th International Conference

Audio networking is one of the great growth areas in audio engineering. Over the last few decades, the use of Ethernet and IP networks in studios, installations, and live audio has been steadily growing, from Ethersound and CobraNet through Livewire and Dante to emerging technologies like AVB (Audio Video Bridging). Audio networking is also a hot research topic in the academic community, with experimental work on low-latency transmission over transcontinental networks and telematic performance. As networking evolves, and as networking infrastructure becomes cheaper and faster, professional audio and other media data are poised to take up a larger portion of the world's overall bandwidth. Audio engineers of all types will likely be affected by networking in the near future, if they aren't already, and the AES is at the forefront of development of the tools to understand and use those networks.

The AES 44th International Conference was held November 18–20, 2011, in San Diego, California, on the campus of the University of California, San Diego. This was the first time the AES convened an international conference on the topic of audio networking, and the first ever opportunity to bring together the major luminaries in this field at a dedicated event. Attendees came from as far afield as Japan, Australia, Saudi Arabia, and South Africa. Given the rapid rate of development and research in networking, the conference was a valuable opportunity to take a snapshot of a field in transition and gauge the major trends that will affect near-term product development and long-term research goals.

Chair of the conference was Nathan Brock, a researcher at UC San Diego in the California Institute for Telecommunications and Information Technology (CalIT2) division. Papers chair was Chris Chafe of Stanford University, Thomas Sporer of Fraunhofer IDMT served as treasurer, while Peter Otto (also of CalIT2/UC San Diego) was secretary. Industry sponsors of the conference included Audinate, the AVnu Alliance, DTS, and MeyerSound, without which the conference would not have been the success it was.

More than 65 attendees participated in a technical program consisting of 17 papers, 5 panel discussions, three major technology demonstrations, and a banquet. These were organized by topic; the field of audio networking is quite broad, and one hope of the conference was that researchers from diverse fields in networking could learn about activity in complimentary areas. Some of these topics included broadcasting use cases for networks, performance over networks, audio network control protocols, and audio network product design.

DAY ONE

The conference opened on Friday morning with remarks from conference chair Nathan Brock. These comments were followed by a paper session on new directions in streaming audio; a highlight of this session was a paper by Kevin Gross predicting near-future developments in audio networking by examining recent trends in media streaming and perceived demand in the coming years. A second paper session followed lunch, this one focusing on network control and distribution. Several authors from Richard Foss' laboratory at the University of Rhodes in South Africa delivered reports on the development of the XFN control standard, while Nicolas Bouillot from McGill University gave a fascinating paper describing a method for delivering multi-

Kevin Gross predicts developments in audio networking.

channel content over the web for a novel music rehearsal application.

Following this paper session was a unique demonstration of networked control protocols. Engineers and developers from a wide variety of manufacturers of networked devices discussed and demonstrated the control aspects of their products. Audinate, Bosch, LabX, UMAN, and MeyerSound were represented, giving the audience an opportunity to compare differences in methodology and functionality. A local network was set up in a demonstration theater, and several different devices controlled audio streams while the developers described their technical capabilities. A spirited question-and-answer period followed, in which interoperability and the relationship between control protocols and various streaming devices were key topics. The evening ended with a Greek-style banquet at the UC San Diego Faculty Club.

Thomas Sporer acted as the conference treasurer.

Peter Otto was the conference secretary.

DAY TWO

Saturday began with a paper session on telematic performance. In these performances, musicians play together over networks despite being thousands of miles apart from one another. Low-latency audio streaming allows the performers to play in sync, within given limits, while streaming video allows audiences at each location to see all of the performers. Various strategies are used to mitigate the inherent transmission delay over networks; latency, and its effects, is a primary concern for researchers in this field. Alain Renaud delivered a paper describing several strategies for compensating for situations in which latency is particularly troublesome, while Alexander Carôt discussed methods for networking the gestures of a conductor to improve coordination between sites.

The entire conference party together with remote contributors shown on the screen in the background.

A panel tackles the topic of distributed performance using telematics: from left, Synthia Payne, Alain Renaud, David Willyard and Alexander Carôt.

Papers chair Chris Chafe performs on cello in San Diego together with a remote Pauline Oliveros, based in Houston.

Nathan Brock introduces an innovative string quartet performance with two players in San Diego and two at UC Irvine (shown on screen).

Pianist John Mark Harris in San Diego accompanies flutist Reiko Manabe in Japan.

After lunch was a tour of the CalIT2 facilities. This included several significant research areas at UC San Diego, including ultra-high-definition video; a 24-channel surround audio space; massively multiscreen display walls; and the CAVE, an immersive 3-D visual environment with accompanying audio.

Kevin Gross then chaired a panel discussion on audio network product design, featuring developers of AVB, RAVENNA, Dante, and CobraNet. The speakers gave descriptions of their protocols, along with implementation strategies for device manufacturers. This was followed by an active discussion period that focused on the resources available to build products taking advantage of these protocols. Understanding the different capabilities and intended uses of each protocol is very important in choosing which protocol to apply to a given use case.

After a short break, Alexander Carôt returned to the podium to lead a panel discussion on telematic performance. The panelists represented both academic researchers and representatives of companies trying to commercialize performance over networks. In particular, all four speakers were concerned with bringing telematic performance to the public, using the public Internet as the transmission network. In the past, most telematic performances have used academic research networks, taking advantage of the quality of service (QoS), high guaranteed bandwidths, and low transmission delays of those networks. In using the Internet for performance, the speakers on this panel, including David Willyard of MusicianLink, Alain Renaud of Bournemouth University, Manfred Rürup of DigitalMusician, and Synthia Payne of the University of Denver, have had to find ways to compensate for low QoS and high latencies. After a series of short talks describing their methods, the panel responded to audience questions exploring the future of this dynamic field.

The final Saturday event was one of the highlights of the conference: an actual telematic performance, using the high-bandwidth research networks of UC San Diego to connect musicians in three sets. The first part of the performance involved Chris Chafe playing cello at UC San Diego, Pauline Oliveros on accordion at Rice University in Houston, and Ricardo Arias playing the innovative balloon kit at La Universidad de los Andes in Bogotá, Colombia. The three musicians improvised together over the network using the audio streaming software JackTrip (developed by Chafe's group at Stanford University), while video was streamed using H.323 devices.

In the second set, Caprice Strings played traditional classical string quartet repertory, including pieces by Bach, Beethoven, and Mozart. Two of the performers played at UC San Diego and the other two at UC Irvine. This was possible because of the highly optimized network between the two UC campuses, which are about 100 miles apart from one another. Using hardware audio-over-IP devices manufactured by Axia, and uncompressed video streaming using UltraGrid software and specialized video cards, the one-way audio delay was less than 10 ms, well below the tolerance of musicians in these performances.

A panel discusses audio over IP networks in broadcasting: from left, Lars Jonsson, Sonja Langhans, Axel Holzinger, and Greg Shay.

Jeffrey Berryman presents his paper on technical criteria for professional media networks.

The final set involved pianist John Mark Harris and flutist Rachel Beetz in San Diego, while keyboard player Chihiro Sato and flutist Reiko Manabe performed at Keio University in Yokosuka, Japan. The transmission medium was JPEG2000 video streaming with embedded audio, using devices manufactured by NTT. The delay for this set, including hardware compression and decompression latencies, was around 750 ms round trip; this is beyond the tolerance of musicians for either traditional performance or improvisation. Instead, the musicians played music written expressly for telematic performance, in which the delay was carefully calibrated and written into the music. In fact, using a video delay device generously loaned by Evertz, additional delay was added to the system to equal a predetermined number of musical beats. The musicians premiered two new compositions by Nathan Brock alongside a canon by Baroque composer Georg Philip Telemann.

DAY THREE

As with the first two days of the conference, Sunday began with a paper session. This session focused on broadcasting, teleconferencing, and wireless audio transmission using networks. Lars Jonsson delivered a report on EBU standardization activities for networked audio, while Karen Collins' paper presented an experiment using many smartphones to create a massive crowd-sourced audio array in a given space. Seppo Nikkilä closed the session with a provocative paper describing possible uses of streaming wireless uncompressed audio with ultra-high sample rates (192 kHz and higher) for home networking use.

Following lunch was an exciting demonstration of an educational application of professional audio networking: a cinema audio master class involving mentor engineers at Skywalker Sound in Northern California

Seppo Nikkilä provokes the audience on the topic of streaming wireless uncompressed audio at high sampling rates.

interacting with students at the USC School of Cinematic Arts. Using uncompressed streaming media over the California educational research network CENIC, and streaming control information, the USC students were able to show their projects in real time to the master engineers and get their feedback in real time using an HD videoconference system. The master engineers could also take control of the DAW sessions at USC using the streaming control data, to comment on the material and suggest alternatives to the students. The audio and video systems in each room were calibrated so the experience was the same at both locations. The conference at UC San Diego observed their interaction and was able to provide comments and questions to both remote locations. USC and Skywalker Sound intend to continue this collaboration in the future to allow regular interaction between professional and aspiring audio postproduction engineers.

Next on the agenda was a panel discussion on future directions for audio networking. Lee Minich described the potential benefits and coming features of AVB, an extension of the IEEE Ethernet standard for streaming media over local-area networks. Kevin Gross discussed recent developments toward an interoperability standard for audio-over-IP currently being written in the AES working group on audio networks. Appearing via telepresence, John Grant gave a talk on coming post-IP networks. Nathan Brock wrapped up the session with a tutorial on wide-area network applications for professional audio.

The final event at the conference was a panel discussion of broadcasting applications for audio over IP networks. Representatives of Swedish Radio, IRT, Telos, and ALC Networks described current uses of audio networks in the radio and television worlds, as well as needs that are not currently being met. Both studio-based and remote applications were discussed, and a wide-ranging question-and-answer session, typical of this conference, explored how the audio networking community might address some of the broadcasters' needs.

CONCLUSION

Overall, the AES 44th International Conference on Audio Networking was a major success. Researchers from diverse areas in the field interacted in unique ways, and attendees were able to get a wide-ranging view of a dynamic field. Many of the initiatives begun during discussions at meals and breaks and conversations started in discussion sessions will no doubt continue over the next few years and help advance the field in unforeseen ways. Look for the second AES conference on audio networking to be held in the near future!