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Innovation and Creativity

A low-latency full-duplex audio over IP streamer

Asbjørn Sæbø and U. Peter Svensson

Centre for Quantifiable Quality of Service in
Communication Systems

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What is LDAS?

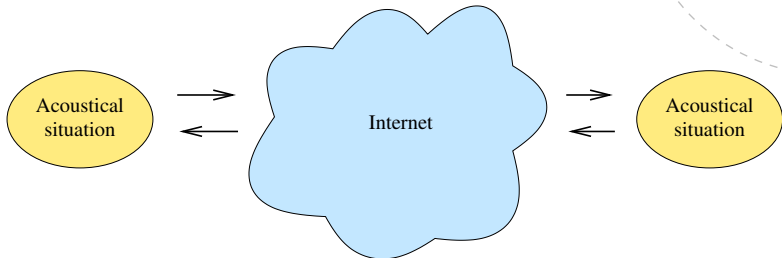
- A Low Delay Audio Streamer in software
 - basically an audio to UDP/IP adapter
 - developed for Linux, using the ALSA sound system
- A research tool
 - distributed multimedia interaction
 - perceived quality of service
- Aimed at demanding applications
 - low latency, high quality multichannel audio

Background and motivation

- Q2S: Audio over IP Networks research area
- Quality beyond voice over IP:
 - Lower latency
 - Multiple channels \Rightarrow higher bit rates
 - Higher audio quality \Rightarrow higher bit rates
- Existing solutions
 - No access to source code, and/or
 - Not fulfilling requirements
- Goal: Fully open software, suitable as research tool

Worldview

Quality of service, as perceived from the endpoints



Scenario: Geographically distributed musicians performing together, with audio (and video) being distributed between all the participants via a connecting IP network.

Previous related work at Q2S/NTNU

Ola Strand:

- Distributed musical performance
- Transmission of audio and video

Håkon Liestøl Winge:

- Music playing over IP
- Measured influence of latency

Otto Wittner / Sigurd Saue:

- Low-delay Windows Streamer

Trond Iver Røste Pedersen:

- Streaming in Java

Requirements

Application: Networked ensemble playing, audio for advanced video conference

- Low latency: Less than 20 - 30 ms for ensemble playing
- Multiple channels: For realistic transmission of acoustic environments and multi-channel 3D audio
- High quality: From CD-quality and upwards

Specification (minimum)

Audio: 44.1kHz/48kHz, 16bit, two-channel PCM, possibility for coding.

Network: UDP/IP, with precautions against UDP shortcomings. No retransmission.

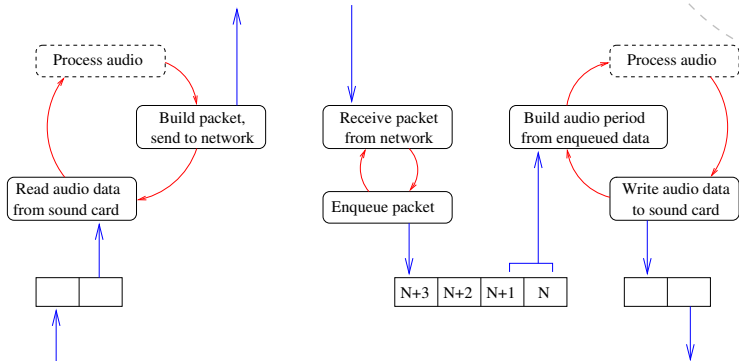
Latency: Less than 20 ms (analog to analog) over LAN.

Synchronisation:

- Receiver and sender must be kept in sync.
- Buffering, to minimise the effects of network transmission time jitter

Implementation

Three threads: Recorder/sender, receiver and playback



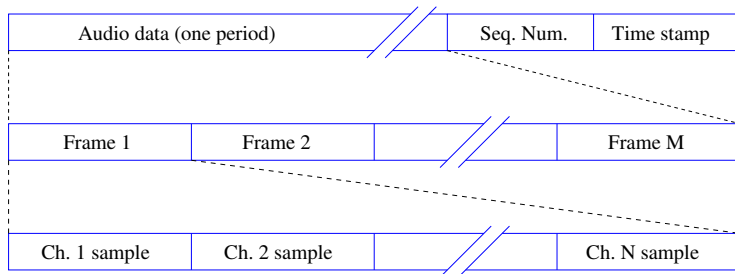
Latency

Audio delivered in *periods*

- Sender sound card buffer: One period of latency
- Receiver sound card buffer: At least one period
- Receiver queue: Adjustable
- Network transmission time
- A/D and D/A: 2 – 3 ms
- Processing latency (software, OS)

Packet format

The payload of the UDP packet:



Packet stream control

Protocol implicitly defined by packet format, sequence numbering and receiver enqueueing combination.

Handles UDP shortcomings and network transmission problems.

- Order packets
- Detect lost/missing packets
- Reject duplicates
- Reject late packets

Missing packets replaced by dummy data. (Possibility: Error concealment.)

Synchronisation

- “Large scale” synchronisation
 - Queue is a sliding window onto packet stream
 - “Early” packet (outside window) \Rightarrow resynchronisation
 - “Too many” late packets \Rightarrow resynchronisation
- Drift adjustment by watermark algorithm
 - Queue length too high \Rightarrow skip single samples
 - Queue length too low \Rightarrow reuse single samples

Results

- Multichannel transmission
 - Two channel
 - Four channel (one-way, early version)
- Full duplex transmission
 - Full duplex version
 - Double set one-way version
- Latency
 - Less than 30ms (analog to analog)
 - Less than 10ms expected for other sound interfaces

Plans and possibilities

Architecture: From sender/receiver and pairwise peer-to-peer to general architecture capable of one-way, pairwise peer-to-peer, multi-way peer-to-peer, client/server and relay solutions

Network timing: Time stamps may be used for transmission time jitter monitoring

Experiments:

- Networked ensemble playing
- Effects of latency
- Transmission of 3D audio

Coding?: Adding packet-based audio coding

Error concealment?: Instead of silence dummy data



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Availability

- Open Source, GNU General Public License
- Download: <http://www.q2s.ntnu.no/~asbj/s/ldas/ldas.html>
- Mailing list: <https://pat.q2s.ntnu.no/mailman/listinfo/ldas-dev>