LOLA
(LOw LAtency audio visual streaming system)

A LOW LATENCY, HIGH QUALITY AUDIO/VIDEO TRANSMISSION SYSTEM FOR NETWORK MUSICAL PERFORMANCES AND INTERACTION
LOLA
(the team working to make the dream come true)

Production

Conservatorio di musica G. Tartini - Trieste

Implementation

Paolo Pachini: general coordination

Carlo Drioli: programming

Nicola Buso: testing and musical advice

Claudio Allocchio (Consorzio GARR): testing and networking advice

Massimo Parovel: conception and supervision
Musical Requirements to Play Together

• Audio Latency below ~75ms (depends on music gender)
• Eyes Contact to synchronize
• Spatial Sound immersion for expression
• Room Reverbering
• Continuous Presence of all musicians
• Non distracting environment
Motivations and Objectives

• Target applications:
  
  • interactive musical tasks
    • Network musical performances
    • Network music education and training

... but also...

• interactive on stage performances
  • Network Dance performances
  • Network Drama performances
  • Network performing arts education and training
  • ...

Consortium
GARR

Conservatorio
di musica
Giuseppe
Tartini
Trieste
Motivations and Objectives

• ... and beyond:
  • remote real time surgery
  • virtual space immersion

• ... you name it...

Let the user invent new possibilities...
Motivations and Objectives

• Challenges

  • Management of synchronous audio video streams over packet networks

  • Minimal delay requirements for interactive task and music performances

  • Optimal balance between AV presentation delay and quality

  • The speed of computer/networking equipments
  • ... and beyond: the speed of light...
Motivations and Objectives

• Targets of the project

  • A system suitable for musical performances relying on both audio and visual communication (but also other applications)

  • A Transparent and Natural end-user interaction

  • Providing lowest possible delay using available technology

  • Low cost and portable equipment

  • Oriented to dedicated high performance networks (LightNet Project, GARR, GÈANT, Internet2,...)
The LOLA system
a very basic schema
(well, what’s the difference with DVTS, CXP?)
First results: 110km, 15 switches, 60fps, B/W

June 4th 2009 - Trieste fiber optics metropolitan network Lightnet
Yes, we can try to play together!

First test with music: September 21st 2009

- Two Pianos, in two studio rooms at Tartini, linked over the loop with LOLA
- Round Trip Latency ~90ms

- monitor on the music score, “as if the other pianist was in his canonical ‘duo position’, e.g. in front”

Tests performed:

- One piano plays alone, with the return audio channel open; sound was coming back, but no echo cancelling needed;
- Two pianos play together some scales and easy exercises;
- Two pianos play together some canone by J.S. Bach;
- The latency is artificially increased to test interaction limits;

- We can try with a full setup and a real Piano Duo to get feedback
Bach Brandeburgh Concerts

Trevisan-Zaccaria Piano Duo: November 5th 2009

• Two Pianos, in two Concert Hall at Tartini, linked over the loop with LOLA
• Round Trip Latency ~80ms, mostly due to CODECs

• Sound Rendering, Room Environment, musician interaction with LOLA environment.

• Tests performed:
  • Play Bach Branderburgh Concerts
  • Roundtrip Latency tests
  • Remote sound in (insulating) earphone vs audio monitors
  • Adaptation techniques to delay

• They can play together, but too much attention is payed to handle the delay. No confortable environment for artistic performance.
• We need to go further down with CODECs delays
The Triangle Test

Experiments without WinSock: December 21st 2009

• Just a Triangle, to make accurate latency measurements
• New Round Trip Latency ~20ms!

• Tests performed:
  • Various buffers configuration to identify optimal results
  • Sound Quality check (sending recorded audio tracks)

• We can give Bach another chance to meet technology!
Bach Brandeburgh Concerts (bis)

Trevisan-Zaccaria Piano Duo: February 4th 2010

• Two Pianos, in two Concert Hall at Tartini, linked over the loop with LOLA
  • Round Trip Latency 20ms (artifically up to 70ms)

• Tests performed:
  • Play Bach Branderburgh Concerts
  • They started to play... and played them all!
  • Natural interaction
  • Many tests to refine the Sound Rendering of the remote piano.
Let’s Try a shared real production network

Trevisan-Zaccaria Piano Duo: October 16th 2010
Trieste-Milan-Trieste loop; ~40ms

- Sound equalisation and spatialisation tests for the “remote” piano;
- It seems to run safely in the middle of the highway:

![Graph showing daily traffic: PoP-TS1 -- PoP-MI2 Side A (17/10/10 10:10)]

- Input Average: Max In: 410.30 Mbps, Av In: 108.76 Mbps, Last In: 43.37 Mbps
- Output Average: Max Out: 302.25 Mbps, Av Out: 74.96 Mbps, Last Out: 34.44 Mbps
The Work In Progress...

- make further tests with musicians;
- make further tests on different network configurations:
  - longer distances;
  - routed networks;
- color impact (on h/w and network bandwidth);
- QoS implementation through DiffServ
- further optimize graphic card rendering;
- “simple” user interface;
- to develop a users’ community and to build common projects;
- to liaise with other potential users
- spatial audio rendering (multichannels)
Questions?

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