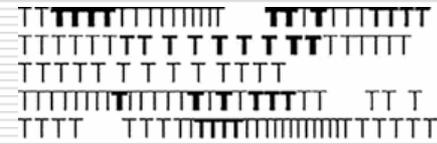


LOLA (LOW LATENCY audio visual streaming system)

A LOW LATENCY, HIGH QUALITY AUDIO/VIDEO TRANSMISSION SYSTEM FOR
NETWORK MUSICAL PERFORMANCES AND INTERACTION

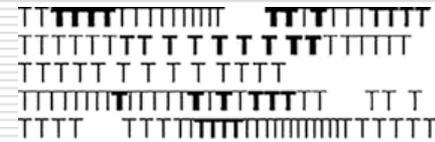
Speakers
Nicola Buso, Carlo Drioli



The Dream...

...at the GARR Conference 2005, in Pisa...

**To perform together, from distant locations...
as if distance has vanished
in a click of a computer mouse.**



LOLA

(the team working to make the dream come true)

Production

Conservatorio di musica G. Tartini - Trieste

Implementation

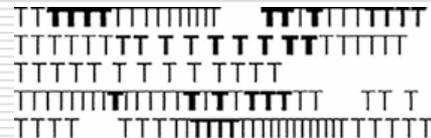
Paolo Pachini: general coordination

Carlo Drioli: programming

Nicola Buso: testing and musical advice

Claudio Allocchio (Consortium GARR): testing and networking advice

Massimo Parovel: conception and supervision

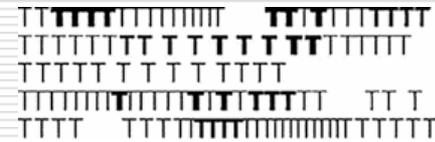


Motivations and Objectives

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

... but also...

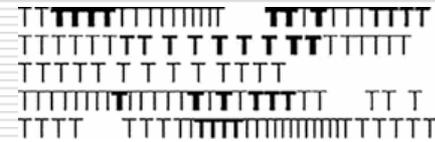
- interactive on stage performances
 - Network Dance performances
 - Network Drama performances
 - Network performing arts education and training
 - ...
-



Motivations and Objectives

- ... and beyond:
 - remote real time surgery
 - virtual space immersion
 - ... you name it...

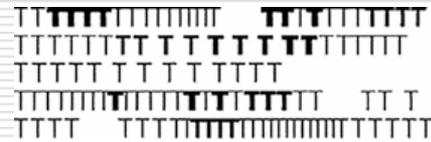
Let the user invent new possibilities...



Motivations and Objectives

• Challenges

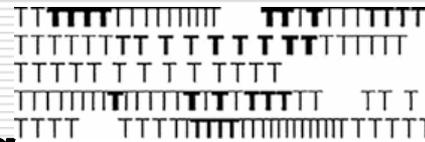
- Management of synchronous audio video streams over packet networks
 - Minimal delay requirements for interactive task and music performances
 - Optimal balance between AV presentation delay and quality
 - The speed of light...
 - ... and of electronic equipment...
-



Motivations and Objectives

- Targets of the project

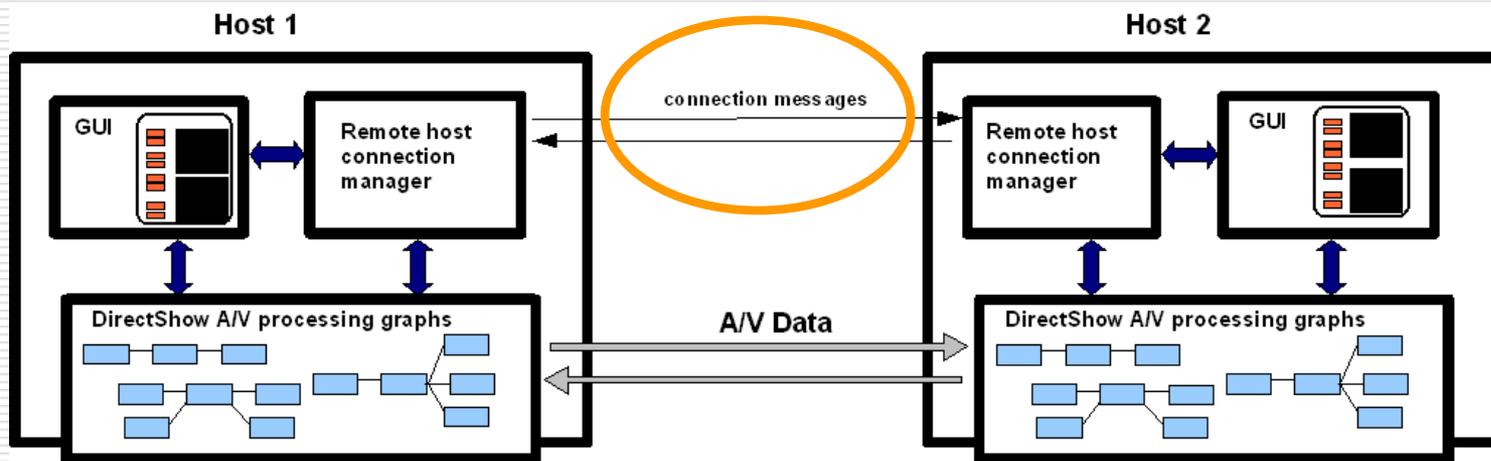
- A system suitable for musical performances relying on both aural and visual communication (but also other applications)
 - A Transparent and Natural end-user interaction
 - Providing lowest possible delay using available technology
 - Low cost and portable equipment
 - Oriented to dedicated high performance networks (LightNet Project, GARR, GÈANT, Internet2,...)
-

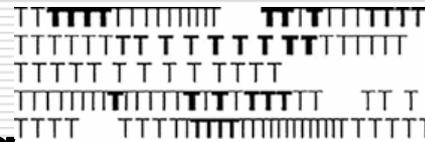


Functions and networking

Connection negotiation and management

- Send/receive and manage connection requests
- Negotiation of audio/video formats and compatibility check
 - Video: 640*480, 30-60 fps, BW/Color
 - Audio: 44100, 16/24 bit, mono/stereo, etc
- Transmission of raw audio and video streams, monitoring

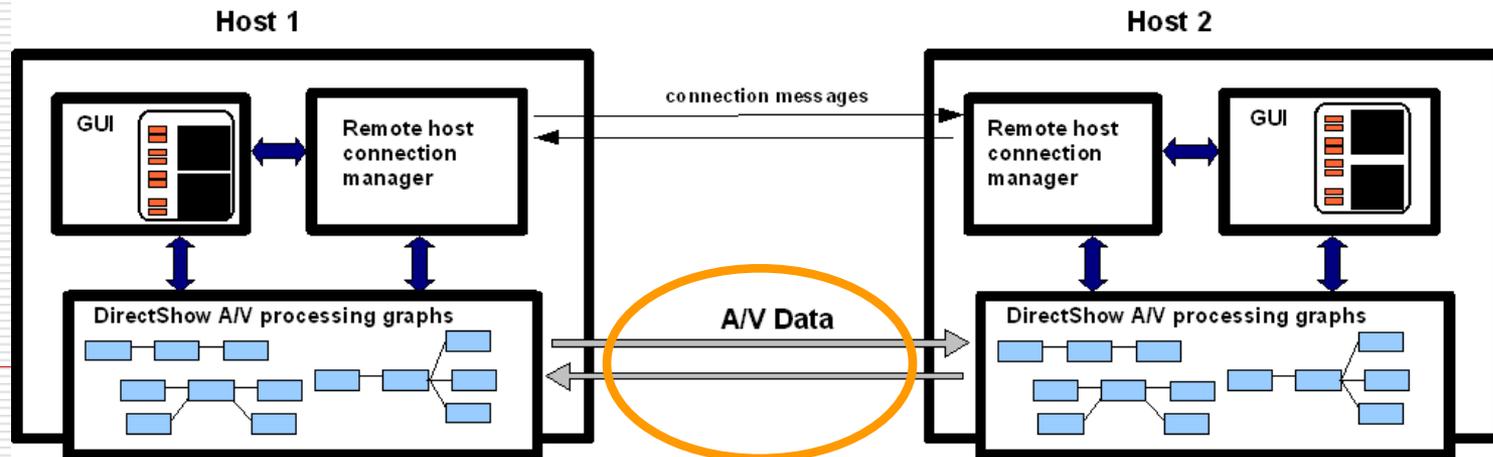


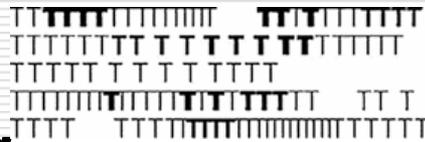


Functions and networking

Audio/Video data grabbing and transmission

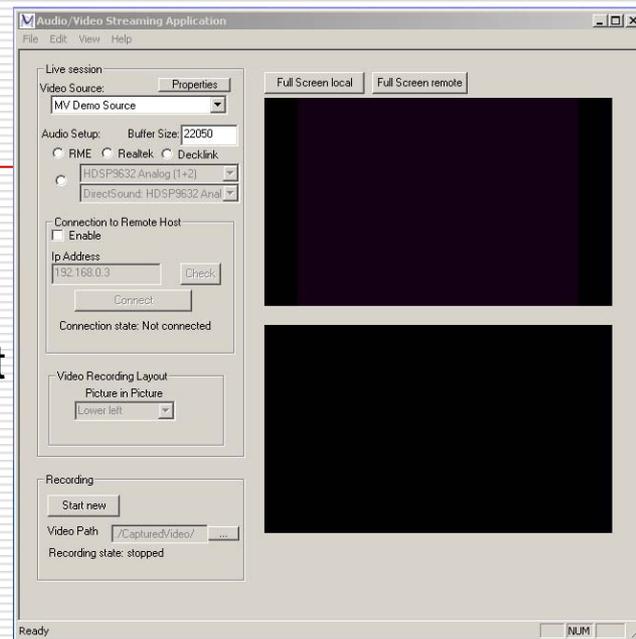
- Grabbing and Tx with low latency devices
 - Video: Grabber BitFlow, BW progressive scan camera
 - Audio: RME HDSP9632
 - Network: 1Gbps Ethernet Card
- Presentation delays (no Tx): < 5 msec (audio and video)
- Delays due to Network: from 1 msec (LAN/WAN) to >10-20 msec, depending on the distance
- On actual networks, jitter buffers are required (delay vs quality balance)
- At present, tests are ongoing on dedicated GARR network setups





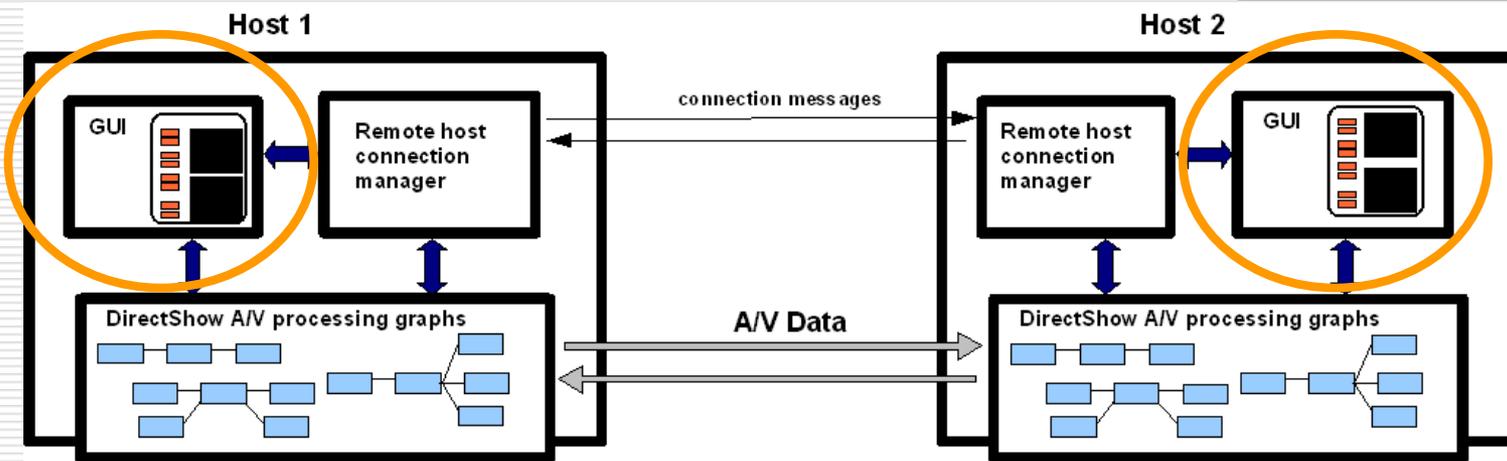
Functions and networking

Graphical user interface



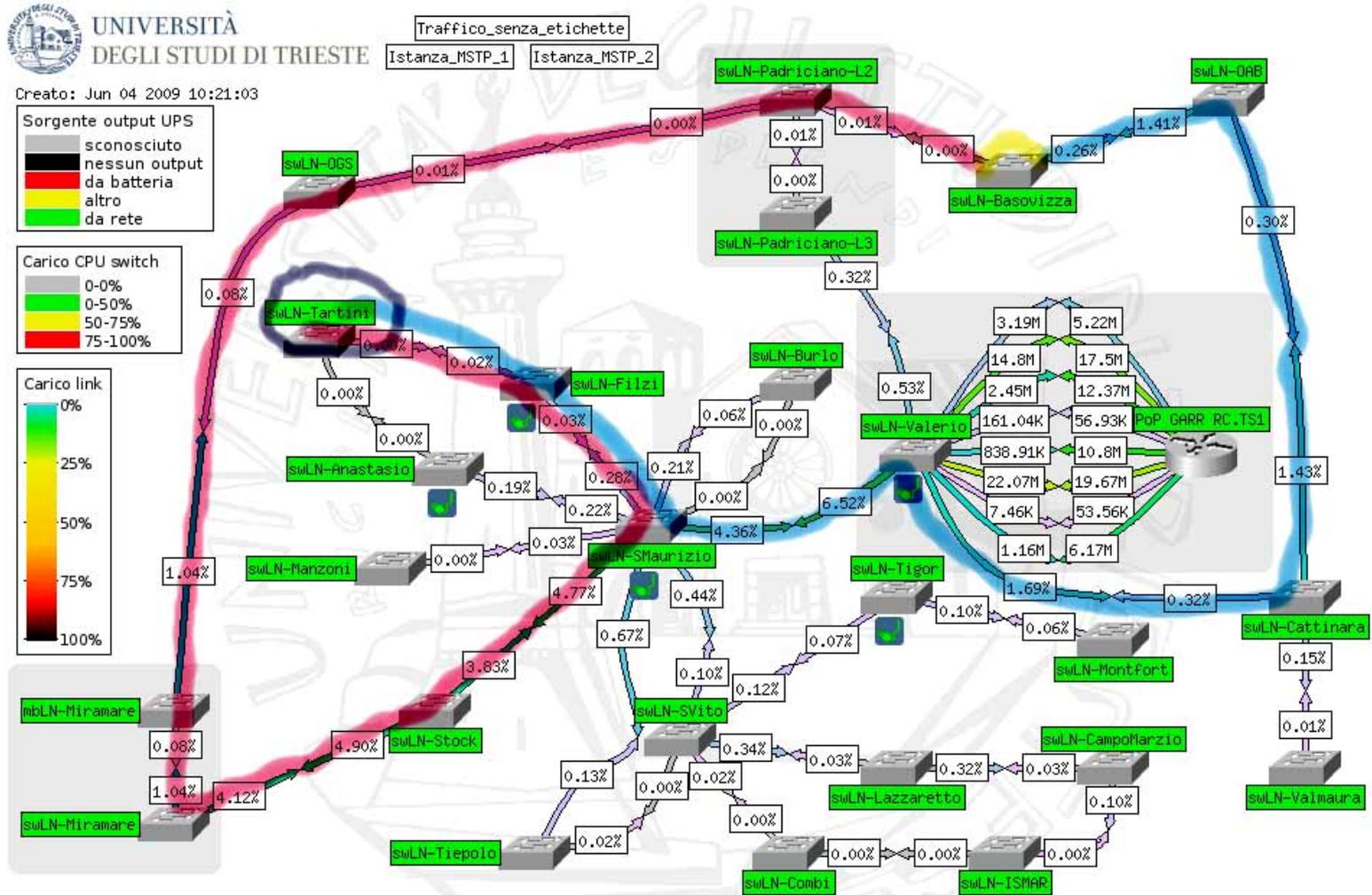
GUI functions

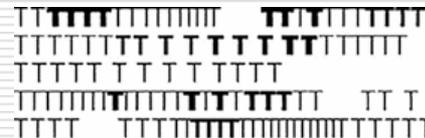
- Controls for connection negotiation and management
- Audio/Video buffering controls
- Visualization options, audio mixer, etc
- Recording



First results: 110km, 15 switches

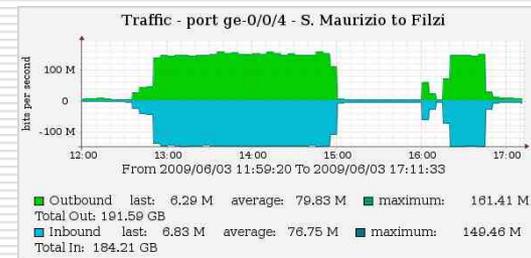
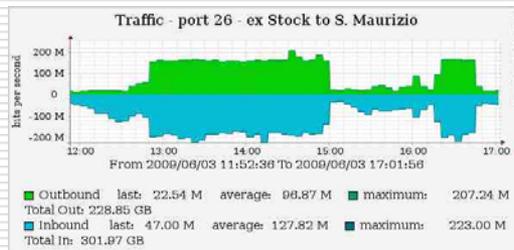
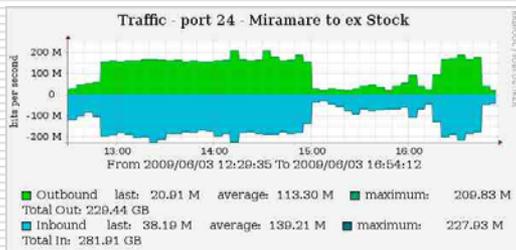
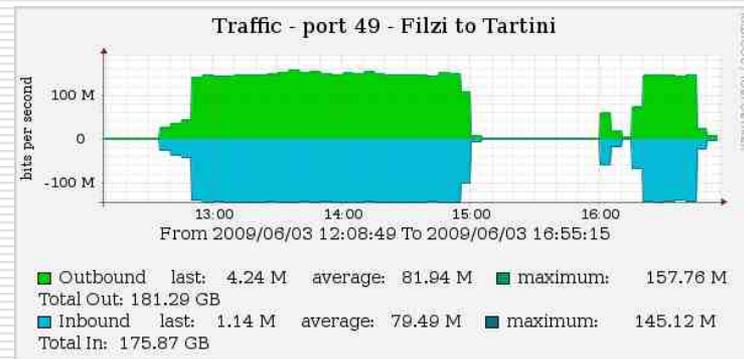
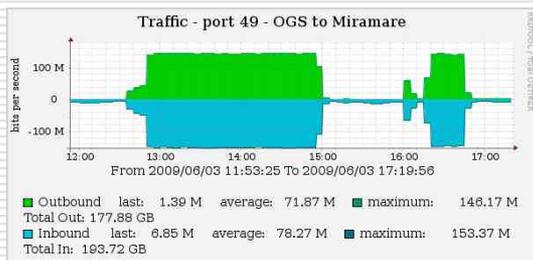
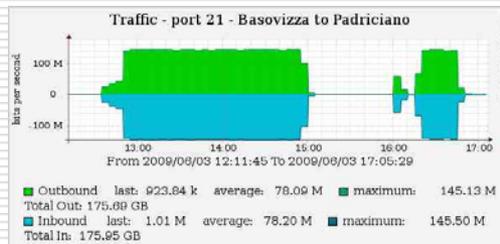
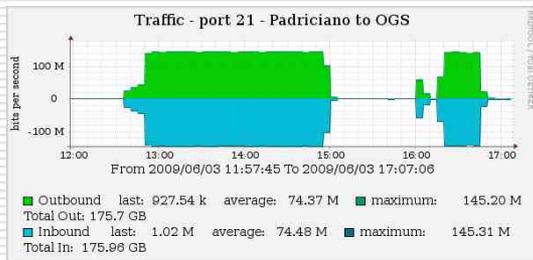
June 4th 2009 - Trieste fiber optics metropolitan network Lightnet

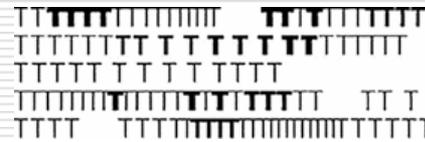




First results: 110km, 15 switches

June 4th 2009 - Trieste fiber optics metropolitan network Lightnet

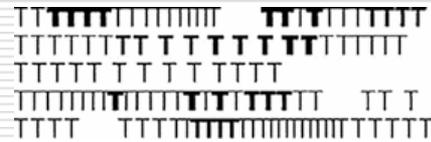




Yes, we can play together!

September 21st 2009, Bach, LOLA flavour

- Two Pianos, in two studio rooms at Tartini, linked over the loop with LOLA
 - 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: up to 150ms there were no problems.
-



The Work In Progress...

- make further tests with musicians;
 - make further tests on different network configurations:
 - longer distances;
 - routed networks;
 - color bandwidth impact (on h/w and network);
 - 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
-

