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GÉANT and LOLA: Enabling real-time remote musical collaboration

Advanced software and high speed research networks combine to let musicians in multiple locations perform together in perfect harmony

Collaboration is at the heart of musical and artistic progress, with the ability to play together increasing creativity and opening up new possibilities for musicians of all types. However bringing musicians together to rehearse and perform can be an expensive and time-consuming process. For a full orchestral performance musicians have to travel back and forth to multiple rehearsals, taking up valuable time and limiting the possibilities for large scale collaboration.

Musicians have long been looking for ways to collaborate more productively, with the advent of the Internet providing a potential channel to enable them to play together in real-time. However the decentralised structure of the public Internet and the sheer amount of traffic it carries leads to delays (latency) and jitter (which introduces unpredictable delays between notes) in both audio and video transmissions between different sites. While latency and jitter are minor inconveniences for normal traffic or audio conferencing, they are a major problem for musicians looking to play together in perfect harmony.Consequently previous Internet-based musical collaborations have been confined to master-classes with just a single musician performing at any one time.

Driven by this pressing demand from musicians and performers, the LOw LAtency (LOLA) project has been developed by the Conservatorio di Musica Giuseppe Tartini, Trieste, and the Italian research and education network GARR. Working together they have created completely new software that enables performers to play together, as if they were in the same physical location, with both pictures and sound shared across the network in real-time. Removing jitter and bringing latency down to less than 60 milliseconds for the round trip from instrument to human ear and back again means that our perception does not notice any delays, fooling the ear into believing that all the musicians are in the same room.

Research networks at heart of collaboration
Achieving this level of performance requires high speed, reliable and stable networks providing guaranteed bandwidth of up to 500 Mbps. These demanding requirements can currently only be cost-effectively met through research networks, such as the pan-European GÉANT network and GARR in Italy.

The Challenge
To enable musicians separated by vast distance to perform together in perfect harmony as if in the same room, opening projects up to wider collaboration and reducing the need for travel.

The Solution
A powerful multimedia network, combining bespoke software and powerful high speed research networks, including the pan-European GÉANT network and GARR in Italy.

Key Benefits
A dramatic reduction in latency and jitter enables real-time musical collaboration on even the most complex scores. Musicians perhaps unable to travel can rehearse and perform seamlessly together across vast distances, without the audio or video delays experienced over the public Internet.

Conservatorio di musica Giuseppe Tartini Trieste

Consortium GARR

Renater

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> As musicians we want to collaborate with our colleagues wherever they are located and were frustrated that the Internet couldn't provide the level of performance that we needed. The LOLA project is very exciting as it combines specially optimised software with high speed, robust, end-to-end networks to enable us to work together in real-time – it feels like everyone is in the same studio for both musicians and the audience. Working with GARR and GÉANT has been vital in achieving our vision now and moving forward.
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> *Massimo Parovel, Director, Conservatorio di Musica Giuseppe Tartini, Trieste.*

To meet LOLA's needs GARR and GÉANT worked closely together, providing consultancy and support to help deliver on the project's vision. Following network tests, a dedicated 1 Gbps set of links is planned across GÉANT to provide the guaranteed bandwidth between GARR and test sites in Europe. In the future, LOLA is investigating using Bandwidth-on-Demand (BoD) to underpin a full schedule of rehearsals, concerts and master-classes. BoD provides a dedicated connection between different locations that can be easily and quickly set up by users when and where they need it.

The first public test for LOLA took place as part of the TERENA Network Performing Arts Production Workshop at the Institut de Recherche et Coordination Acoustique/Musique (IRCAM) in Paris in November 2010. The Teresa Trevisan and Flavio Zaccaria Piano Duo, from the Conservatorio Tartini, successfully played together in real-time – with one in Paris and the other in Trieste. The two sites were connected using an end-to-end link that used the Conservatorio Tartini Local Area Network (LAN), the Trieste Lightnet Metropolitan Optical Network, the GARR backbone, GÉANT, the French RENATER research network backbone, the IRCAM 1Gbps last mile and the IRCAM LAN.

> Current Internet technology is simply not able to cope with real-time musical collaboration, so we had to rewrite the software from scratch. To achieve audio and video performance on this scale requires the highest levels of network speed, performance and reliability. The services that GARR and GÉANT provide are critical to underpin the LOLA project and bring musicians together to play in harmony across Europe.
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> *Claudio Allocchio, Senior Coordinator for Advanced Application Services, GARR.*

LOLA's world premiere

Following the Paris test, the LOLA team has been working on a full production version of the software, which can be easily installed and run by local teams at universities or music schools. This adds more audio channels to the software to assist with acoustics and higher resolution colour video, all of which require even greater network bandwidth. At the current stage of development, the plan foresees further tests and demonstration, including an event at the world-renowned Gran Theatre del Liceu in Barcelona in June 2011. A link with Trieste will see two violinists play together in real-time, combining video and audio to provide a seamless performance. This will be followed by ambitious plans for musicians in multiple locations to perform together as a virtual music group in the autumn of 2011, demonstrating the potential of LOLA to help musical collaboration.

LOLA is already being tested around the world. The project team has collaborated extensively with US colleagues at both the Internet2 network and musicians such as the New World Symphony Orchestra in Miami, who are both working with the software. This expands the use of LOLA and demonstrates its global relevance.

The technology behind LOLA has applications far beyond music, and is already being used at Stanford University in the US as part of studies into human perceptions of latency. Other performing arts which can benefit from real-time collaboration, such as dance and theatre, can also use the software. In the field of medicine, LOLA could enable surgery to be carried out remotely in real-time by experts hundreds of miles away as well as enabling the teaching of new techniques across Europe.

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The world is criss-crossed with high-capacity data networks, connecting and serving research and academic institutions across the globe. Separate from the public Internet for reasons of security and performance, these networks make an enormous practical contribution to research in a wide variety of areas - saving lives, building knowledge, and establishing real-time collaboration between researchers all over the world.

GÉANT is the pan-European data network dedicated to the research and education community, built and operated by DANTE. Together with Europe's national research networks (NRENs), GÉANT connects 40 million users in over 8,000 institutions across 40 countries and supports research types as diverse as medicine, climate change and performing arts.

GÉANT and GARR provide LOLA with the reliable, dedicated and high speed connections to allow combined musical performances. This innovative use of technology enables performers hundreds of miles away to play together in harmony, extending the possibilities of musical collaboration.

For more information:

GÉANT http://www.geant.net
LOLA: http://www.conservatorio.trieste.it/artistica/ricerca/progetto-lola-low-latency
Conservatorio di Musica Giuseppe Tartini: http://www.conservatorio.trieste.it
GARR, the Italian Research & Education Network: http://www.garr.it
RENATER, the French Research & Education Network: http://www.renater.fr
TERENA: http://www.terena.org/activities/network-arts/