Architecture for the Real-Time Monitoring of Noise Pollution and Marine Mammal Activity .

Mike van der Schaar, Serge Zaugg, Ludwig Houégnigan, Joan V. Castell, Michel André

Laboratori d'Aplicacions Bioacústiques, Universitat Politècnica de Catalunya, 08800 Vilanova i la Geltrú, Espanya. www.lab.upc.es

Abstract. *Presented is the architecture for noise and marine mammal monitoring as it is currently implemented in ESONET through the LIDO (Listening to the Deep Ocean Environment) project. LIDO will detect in real-time changes in the background noise levels and register acoustic events (natural, biological and anthropogenic), and identify and track the sources when possible. As the system will be implemented in varying environments, a modular design is used that can be adapted easily, based on local requirements. While the system will most often run from a shore station, a more limited version is developed that can run autonomously with minimal power requirements.*

Keywords. *real-time monitoring, acoustic pollution.*

INTRODUCTION

As acoustic pollution in the oceans is increasing, monitoring is becoming more important, with special attention on the noise effects on the behaviour of cetaceans. In the near future governments may require constant monitoring during sea construction projects or operations. One major construction activity in the coming years will be the construction of wind farms. Not only will these farms produce a constant low level noise in their direct environment while operating, but the building of the foundations necessary to support the wind mills will produce impulsive noise dangerous to any cetaceans in the area and lethal to, for example, fish larvae. For these reasons, noise monitoring has become one of the objectives of the European Seafloor Observation Network (ESONET), to investigate the level of noise produced around European coastlines and its impact on the environment and cetaceans especially.

DESCRIPTION

The LIDO (Listening to the Deep-Ocean Environment) acoustic data management will be first implemented in the east of Sicily at a test site operated by the Laboratori Nazionali del Sud of the INFN, as part of a platform for the detection of geohazards and neutrinos, located at 2100 m, about 25 km offshore the Port of Catania (Sicily, Italy). Recordings are made on four channels at 96 kHz and are digitized at 32 bit at the hydrophone array. The digital data is then sent to a harbour station through an optical cable where it first arrives at the Acoustic Data Server (ADS). This server has a graphical user interface that allows an operator to see a spectrogram of the incoming data and is responsible for distributing the data on shore. The ADS will forward the data to real-time analysing servers operated by the UPC and CIBRA and a local Raw Acoustic Data Server (RADS). The RADS takes care of buffering and compressing the data before sending it over a wireless link to the LNS. Additionally, a Processed Acoustic Data Server (PADS) can be used by the analysis systems to temporarily store analysis results before they are sent to the LNS. The raw acoustic data will be stored permanently at the LNS in the Main Acoustic Data Server (MADS) where it can be accessed by collaborators. Other data, such as the analysis results, can be distributed through a webserver to the internet.

The UPC data analysis is performed in two stages. The first stage is designed to be able to run on an autonomous system, close to the hydrophone array itself. It makes a quick decision on the contents of a data segment. If it does not find any interesting signal (impulse sound, frequency modulation, constant tonals), it will discard the segment and only keep some statistical information on the noise level found. If the system is configured to make the information available to the public in real-time, a spectrogram and 1-channel compressed audio stream are retained as well. The resulting information and data segments that are considered interesting can either be stored locally or transmitted directly to shore for a second stage analysis. For LIDO, this stage is done in the harbour station.

At the second stage, sound sources are identified, located and tracked. Impulse sources can be located if the system has enough channels available, based on the time delay of arrival at the hydrophones. Accumulation of information at this stage may give more precise locations over time, and will allow tracking of the sources. Sources will be identified as natural events, shipping

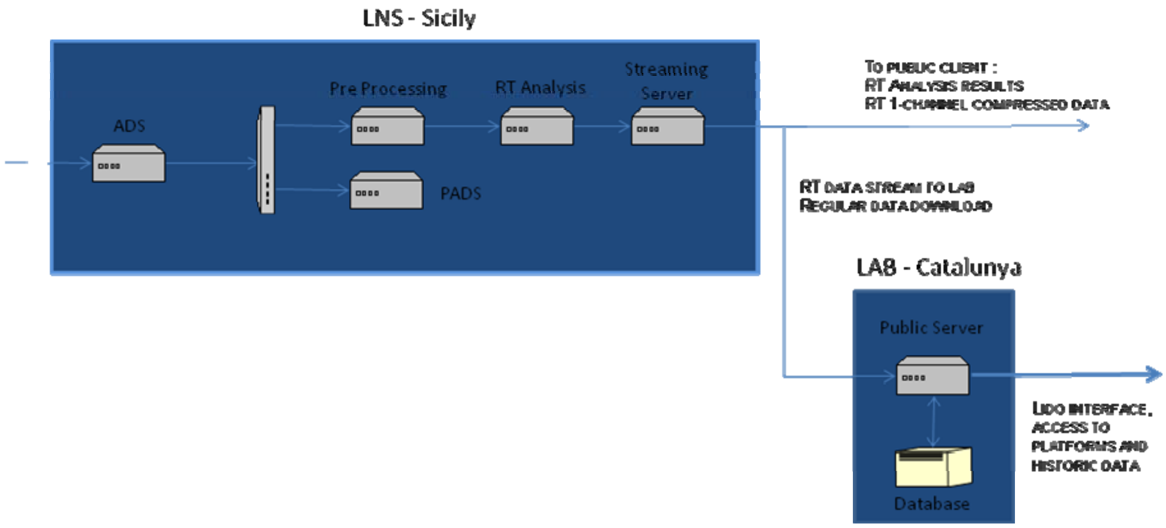

Fig. 1. Schematic of data handling in LIDO; the wireless connection between the harbour and INFN is not shown.

traffic (with possibly the type of ship), or the animal species that produced the sound. In order to correctly identify the sources a catalogue will have to be compiled with information of the natural and anthropogenic sound sources in the area.

From the streaming server at the LNS in Catania, a number of data streams will be made available. Apart from the analysis results that are sent to the LAB to be stored in a database, the server will also provide a compressed audio stream and analysis results to the general public. Conforming to the Sensor ML standard, sensor and hardware information will be made available from the website. Additionally, it is foreseen that Sensor Alert Services will be made available where visitors can subscribe to receive notification of specific events (e.g. cetacean presence or high background noise levels).

The web server at the LAB collects analysis information from all platforms that have implemented the LIDO framework. This will allow correlation analysis between events or to find long term trends at a specific site as well as between different sites. The information will be available to the general public through graphical representation, together with a library of compressed audio recorded at the platforms for educational purposes. Furthermore, a flash client will be available to visitors that can be used to access the real-time data streams directly from a platform.

ACKNOWLEDGEMENT

This project is funded under the European Commission contract FP6-2005-Global-4 - ESONET 036851-2. The LIDO consortium is formed by: Universitat Politècnica de Catalunya (UPC); Instituto Nazionale di Geofisica e Vulcanologia (INGV); Instituto Nazionale di Fisica Nucleare (INFN); Consejo Superior de Investigaciones Científicas (CSIC); Tecnomare; dBScale; Universidade de Lisboa (UL); Centro Interdisciplinare di Bioacustica e Ricerche Ambientali (CIBRA); Consiglio Nazionale delle Ricerche (CNR); Technische Universität Berlin (TUB); Zentrum für Marine Umweltwissenschaften (MARUM).