Methodologies and Technologies for real-time monitoring and tracking of underwater species

The problematic

“Climate Change and human activities such as overfishing are endangering biodiversity in the seas and oceans”

“Marine Protected Areas (MPAs), are required to preserve the ecological integrity of certain ecosystems”

One solution

Improving MPA

1

Developing new tools and instruments

2

Gather data and study environmental patterns

3

Policy-Making

Improving MPA

1

Engineering

2

Biology - Environmental science

3

Politics

Developing a miniaturized bidirectional acoustic tag

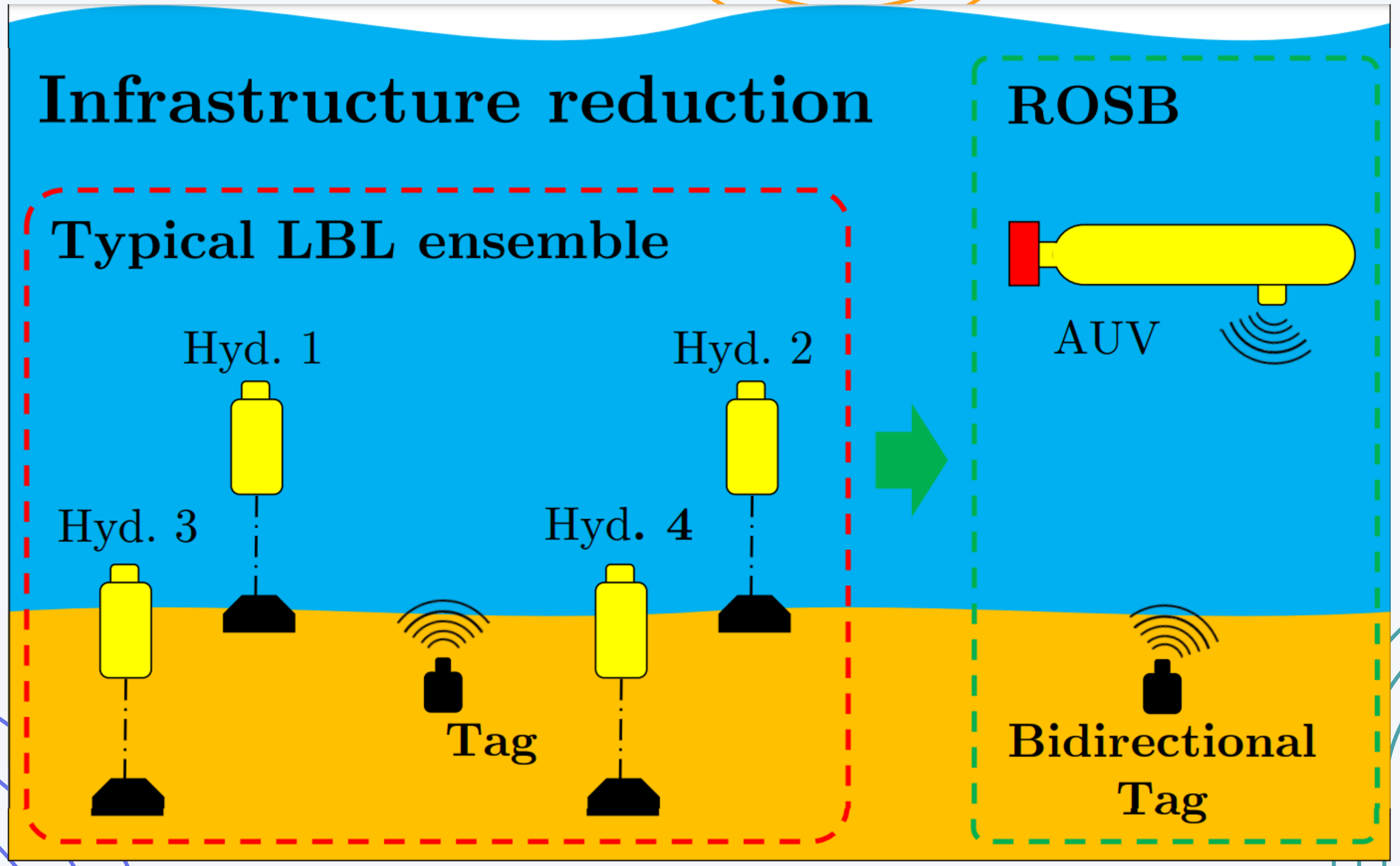
What is an acoustic tag?

Deployment issues

- Huge deployment infrastructure
- Complexity over precise localization

Bidirectionality

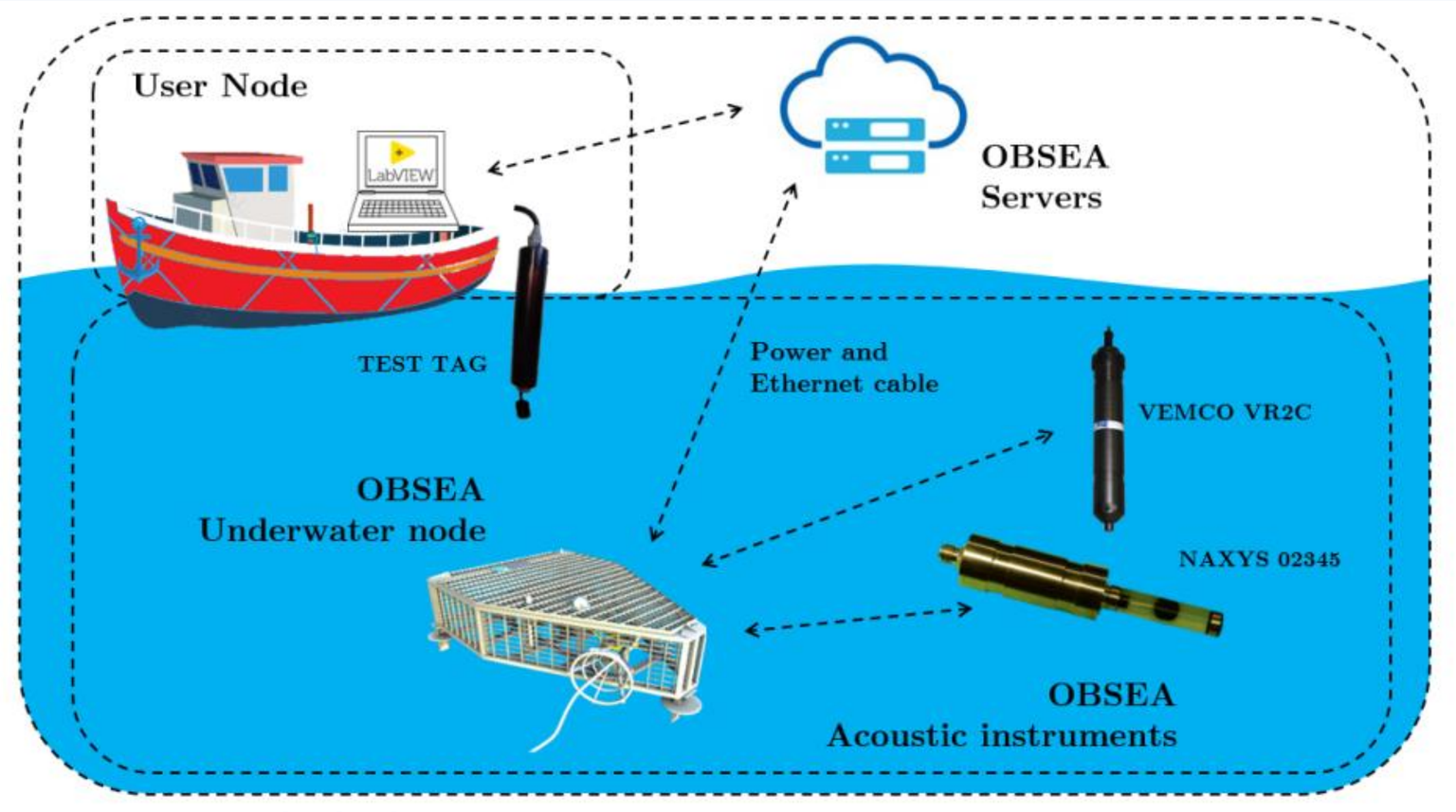
- Interrogation
- ToF: Time Of Flight
- Range Only Single Beacon (ROSB)


Infrastructure reduction
Typical LBL ensemble
Hyd. 1
Hyd. 2
Hyd. 3
Hyd. 4
Tag
ROSB
AUV
Bidirectional
Tag

Objectives

- Design the novel bidirectional tag
- Regulate the connections via Medium Access Protocol (MAC)
- Biological deployment Campaigns

Progress made



Engineering a testbed for bidirectional acoustic tag development

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***Abstract*—Marine protected areas (MPAs) have been implemented to mitigate the effects of climate change and overfishing on various marine ecosystems. Nonetheless, these areas need monitoring to ensure their actual utility. Tools like acoustic tags are used to study the animals' behavioural patterns and obtain valuable information to improve MPAs. Recently, new architectures have been proposed to overcome the inherent limitations of off-the-shelf tags, for example, by implementing bidirectional communication capabilities with the newly developed open protocol from European Tracking Network. In this paper, the testbed topology and methodology used to develop these bidirectional acoustic tags are discussed alongside the laboratory results achieved.**

***Index Terms*—Bidirectional, Acoustics, Tag, Marine protected areas, Underwater technology**

I. Introduction

Anthropogenic carbon dioxide plays a significant role in oceanic ecosystem stability (e.g., acidification) [1]. This process endangers mostly coralligenous zones, the second-richest Mediterranean habitat in terms of biodiversity, close to Posidonia oceanic meadows [2].

Even though fishing has been practiced for 90000 years, the paradigm has shifted, due to the industrial revolution. Since the 1900s fishing has intensified, and sea and oceanic operations have deepened from 0-500 m to 2000 m below sea level, with WWII as an enhancer due to the newly developed technology for the oceanic and maritime military operations in this era. These acts caused a significant disruption in the trophic chain with an increment of fish and organisms on the lower shelves and a decrease of those on the upper ones.

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These captures uprising tendency was only paused when the UN Convention on the Law Of the Sea (UNCLOS) appeared and some meteorological events, such as *el niño*, occurred. New measures, like the creation or expansion of Marine Protected Areas (MPAs), are required to preserve the ecological integrity of certain ecosystems impacted by overfishing and to control the damages caused by acidification [3].

MPAs have faced improving changes since what is considered the first, located in Fort Jefferson National Monument (Florida) in 1962 [4]. Nowadays six different categories are regulated, including various types of activity restriction and ecosystem protection [4]. To ensure the MPA's long-term viability, biological and geological studies have to be performed [5], and tools like acoustic tags provide valuable behavioural data that helps inform policy-making institutions [6], and decide which management is most appropriate for each zone [7].

Recent studies have demonstrated the effectiveness of MPAs in the northwestern Mediterranean Sea [8], [9]. Specifically, fine-scale movements of different tagged Norway Lobsters (*Nephrops norvegicus*) were studied to determine the suitability of the MPA's size proposed for this spice. The study used four moored hydrophones and underwater vehicles to triangulate the tagged individuals at 350 m depth. These receivers had to be placed specifically at certain locations, and a complex post-processing method was required for their calibration to obtain precise localization points. The deployment and recovery costs of such receiver networks are considerable, especially in deep waters.

Off-the-shelf acoustic tags are offered in various sizes and capabilities, but all feature unidirectional communication to a receiver or data logger. Previous articles have proposed a bidirectional acoustic tag topology, its electronic design, and a suitable Frequency Shift Keying (FSK) modulation protocol to communicate with the tag and the Pulse Position

The OBSEA has been also thought of as a place to develop new technology in the field of acoustic devices to improve

Tests have been conducted to know and characterize the power consumption over a range of 5 kHz to 120 kHz using

generated and instruction set used) are carried out using a

$$e_k = \{(t \cdot f \cdot 0.2) - (t \cdot f \cdot 0.2)\} \cdot \frac{}{2000 \cdot f} \quad (1)$$

thank you!

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