# Underwater Acoustic Sensor Network Localization and Challenges

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## UWASN

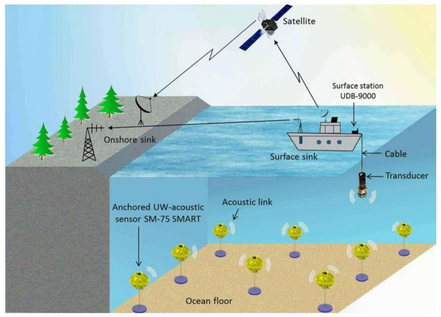
An Underwater Acoustic Sensor Network (UWASN) is a system that provides access to wireless communication underwater.

## Operations

The network is composed of:
- Probes
- Surface Station

In order for information to be transmitted to the surface:
- Probes are placed in the water that communicate through acoustic waves
- Information is then sent to a surface station where it is processed and retransmitted using radio waves

Through this system information can propagate from:
- Surface to Probe
- Probe to Probe
- Probe to Surface




[1] An architecture of an UWASN

## Applications

- Military
  - Submarine Communications
  - Surveillance
- Commercial
  - Underwater GPS
  - Oil Reservoir Locating
- Environment
  - Pollution monitoring
  - Natural Disaster Watch

## Probes

SM-75 Probe:
- Features
  - Dive 22,000 ft. Deep Ocean
  - Weighs 40 lbs.
  - 24 in. Diameter
  - 22.5 in. Tall
- Design by Layer
  - Internal Hardware
  - Contained within a glass sphere that maintains pressurization
  - Externally protected by a yellow hard hat

Probes

## Localization

Localization is the act of pinpointing the exact location of individual probes in a network. This is importance, because it allows for accurate measurement of the offset of time from send to receive, necessary for the reference in location, and the location at which the information was collected.

## Challenges and Objective

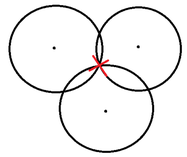
Challenges:
- Overhead due to energy consumption
- Scenario applicability
- Synchronization offset
- Bandwidth size
- Variable delay due to propagation through medium

Objective:
- Produce a system that is adaptable and efficient

## Approaches

While some applications for UWASN require an exact location for each and every individual probe, at times there are applications where a less precise location will suffice. This can be preferred due to its lesser overhead resulting from a reduced number transmissions.

Area Localization



Multilateration

## Methodology

- RSSI (Received Signal Strength Indication)
- ToA (Time of Arrival)
- AoA (Angle of Arrival)
- TDoA (Time Difference of Arrival)

## Localization Components

- Probes
  - Diving
  - Anchored
- Mobility
  - UAV (Underwater Automatic Vehicle)
  - UUV (Unmanned Underwater Vehicle)
- Surface Communicators
  - Buoys
  - Diving Probes

## Experimentation and Lab

Architectures refer to the design of the underwater system, and algorithms refer to the different combinations of methods.

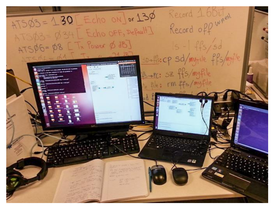
A day on the lake

## The WiNES Lab

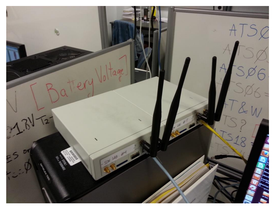
Prelaunch at Lake LaSalle

Producing algorithms and architectures of novel quality is quite challenging. To subsidize the difficulty, I was assigned multiple articles on architectures and algorithms. From there, I was required to learn about radio communications, python language and the use of hardware such as USPRs. All of this was put together in gnu radio companion, which was my biggest focus in lab. While in lab I also dissected a probe.

When algorithms and architectures of suggestible novelty did occur, we set out on the boat in lake LaSalle where experiments were performed.



Desk Terminal



USRPs

## Future Work

In the future I hope to produce a novel method that addresses overhead efficiency, applicability to different scenarios and data reliance.

## References

[1] Hovannes Kulhandjian / University at Buffalo PhD student http://news.wbfo.org/post/researchers-work-develop-wireless-internet-underwater