

# Low-Cost Underwater Communications

Sprint 1: Jonathan Anischenko, Amanda Maas, Glenn Martinez, Jeremiah Sullivan

# Product Mission

Mission: To make underwater communication more affordable for recreational scuba divers. By harnessing the capabilities of tools the user already owns (smartphone) and the Chirp API, we can provide a lower-cost method for underwater transmission of voice as well as data. Our product will thereby make the dive experience more enjoyable, as well as safer.



# Target User

## **Recreational Scuba divers who own a smartphone:**

- I, the diver, want to broadcast simple messages.

I do not want to carry around a big device.

I want the receivers to uniquely ID my messages.

I want a simple interface using gestures or big buttons.



# Additional User Stories

- **I, the divemaster, want to:**
  - Monitor my divers
  - Receive regular updates
  - Be notified if a diver is in need of help
  - Ping only my own divers
- **I, the boat captain, want to:**
  - Send and receive status updates
  - Check in with individual or groups of divers
  - Receive regular updates from all of my divers
  - Send updates to subsets of divers.
  - But, I don't have restrictions on the bulk of the system.



# Possible Future User Story

- **I, the budget-conscious researcher, need to:**
  - Collect and transmit data from underwater sensors to buoys/boats/divers
  - Conduct my research within a limited budget



# MVP

This is a multidisciplinary project that will require intense iteration.

The minimally viable product is a computer that can:

- Send a set of data to a remote computer.
- Send a select set of messages
- Display the received message clearly on the receiving machine

-Further complexity can be added, as time allows.



# User Interface

Two separate interfaces should be considered:

- **Underwater Interface:**
  - Simple
  - Gesture-based
  - Large Buttons
- **Surface Interface:**
  - Full computer interface for development (size/space are not of concern)



# Product Survey

Existing Products:

- Rudimentary
- Very Expensive





# Product Survey

## Voice Communication Systems

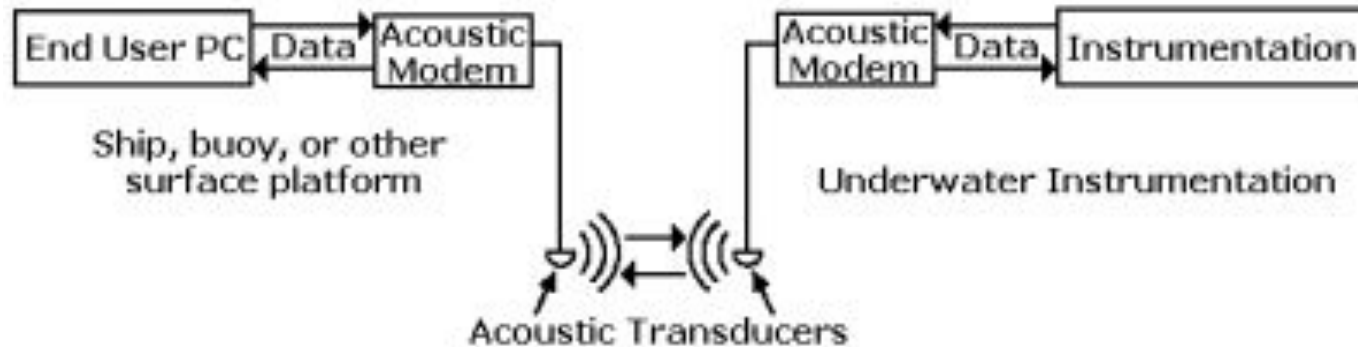
- Buddy Phone for Full Face Mask
  - \$819
  - Voice Communication only
  - Provides diver-to-diver and diver-to-surface comms
  - Two channels
  - 500 meter range
  - Includes microphone, transducer (earphones)
  - Hands-free mode
  - 30 meter operational depth
  - 0.5 W output power
  - 9 Volt battery-powered



<https://www.leisurepro.com/p-otsbpg/buddy-phone-for-full-face-mask-2-channels>

# Product Survey

## General Data Transmission Systems



Basic Acoustic Communication Model.  
Diagram courtesy of Benthos, Inc.

<https://dosits.org/people-and-sound/communication/how-is-sound-used-to-transmit-data-underwater/>

# Product Survey

## General Data Transmission Systems

- Modem component alone can be prohibitively expensive for our users
- Systems are generally used by established organizations with larger budgets (oceanographic institutes, large research organizations, governments)
- These systems are very sophisticated (compared to available scuba voice communications systems)
- Building a system would require many component (modem, transducer, microphone, etc)



# Intellectual Property Analysis

- Patent Class 367 - Communications, Electrical: Acoustic Wave Systems And Devices - (Subclass 131 - Underwater System)
- US Secretary of Navy (Patent) - A method for mobile underwater acoustic communications includes double differentially (DD) encoding a communication signal to produce a DD-encoded communication signal, applying direct sequence spread spectrum (SS) to the DD-encoded signal to produce a DD-SS communication output signal, and transmitting the DD-SS communication output signal.
- Underwater Technologies Center Ltd, Divecom Ltd (Patent) - An underwater apparatus for transmitting and receiving high rate data and voice communication including a transmitter, a receiver, and a Doppler frequency shift compensator.
- Multiuser acoustic communications with mobile users (Paper from the Journal of the Acoustical Society of America)
- 殷敬伟韩笑张晓◆郭龙祥 (Chinese Patent) - Bionic underwater acoustic communication method based on differential delay difference encoded pattern

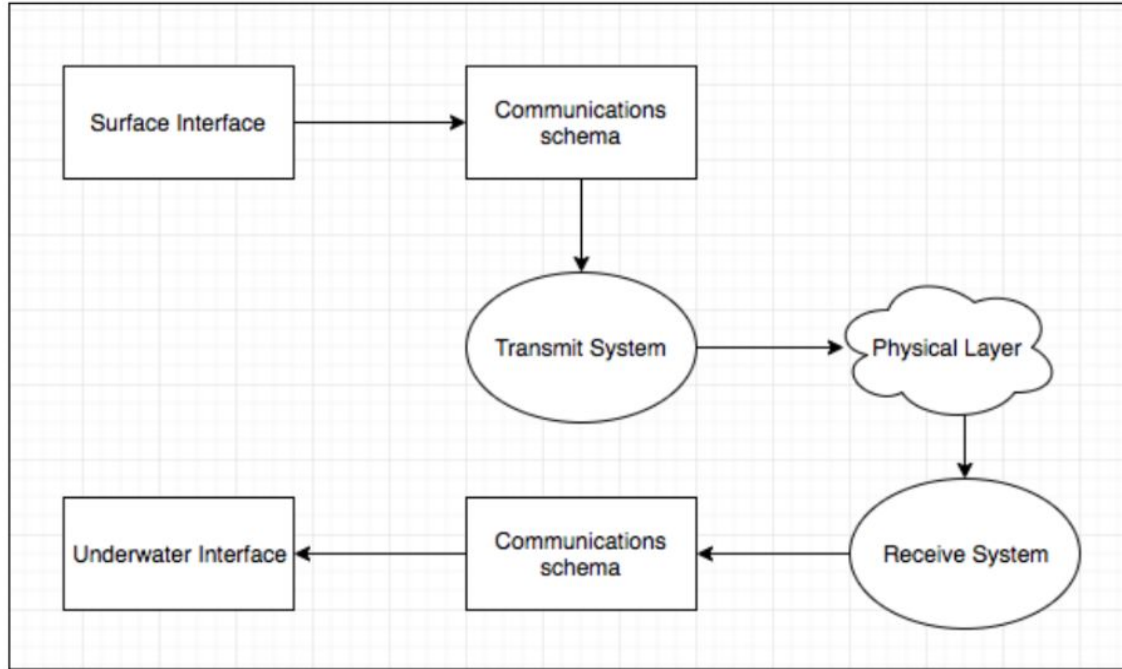
# Intellectual Property Analysis (cont.)

## Github Repositories:

- Applidium/AudioModem - Transfer data using microphone/speaker on iOS devices (Copyright)
- Cawfree/OpenChirp - An open source implementation of the Chirp data-over-audio protocol (Apache 2.0)
- Jamesonrader/CUE-Ultrasonic-Transmissions-Protocol - Transmit data using ultrasonic audio. Useful for offline/network-free data transfer, automatic content recognition (ACR), and broadcast. (Demo only for personal use)
  - CUE Audio, LLC - Company dealing with acoustic data transfer at large scale  
<https://www.cueaudio.com/>



# System Design



*Basic System*

# Technology

## Chirp API

- Few existing apps for acoustic communication
- Chirp is the most advanced and deployable tech found
- COTS hardware will be used for the purpose of rapid development
- Chirp API allows us to test platform viability



# Test Program

- Used example code from GitHub that demonstrates the basics of the Chirp API.
- Program involves the sending of messages between two devices capable of sending and receiving messages with Chirp.
- Devices used laptop with Python code and iOS app provided by Chirp.





# Input

```
\Semester Project>py messenger.py Hello_World
```



Python  
Script



Message



# Output

