UOWC

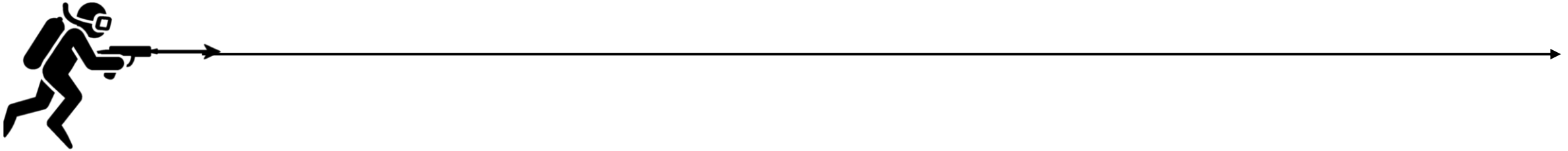
Underwater Optical Wireless Communications

Equipa 19

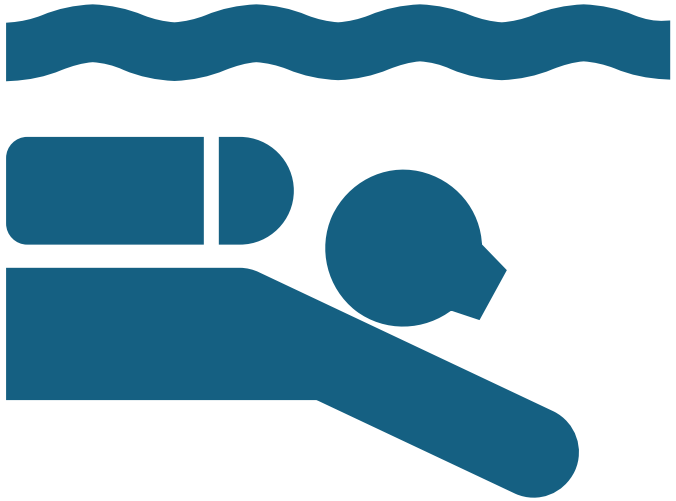
- Ricardo Rodrigues
- Mauro Cordeiro
- Afonso Frazão
- Rodrigo Quina
- André Salvaterra

TÉCNICO LISBOA

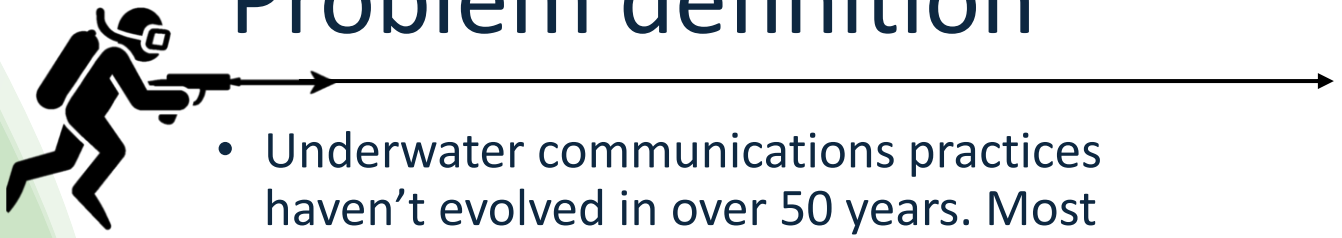
Introduction



Have you ever thought why most divers still use hand signals ?



Problem definition

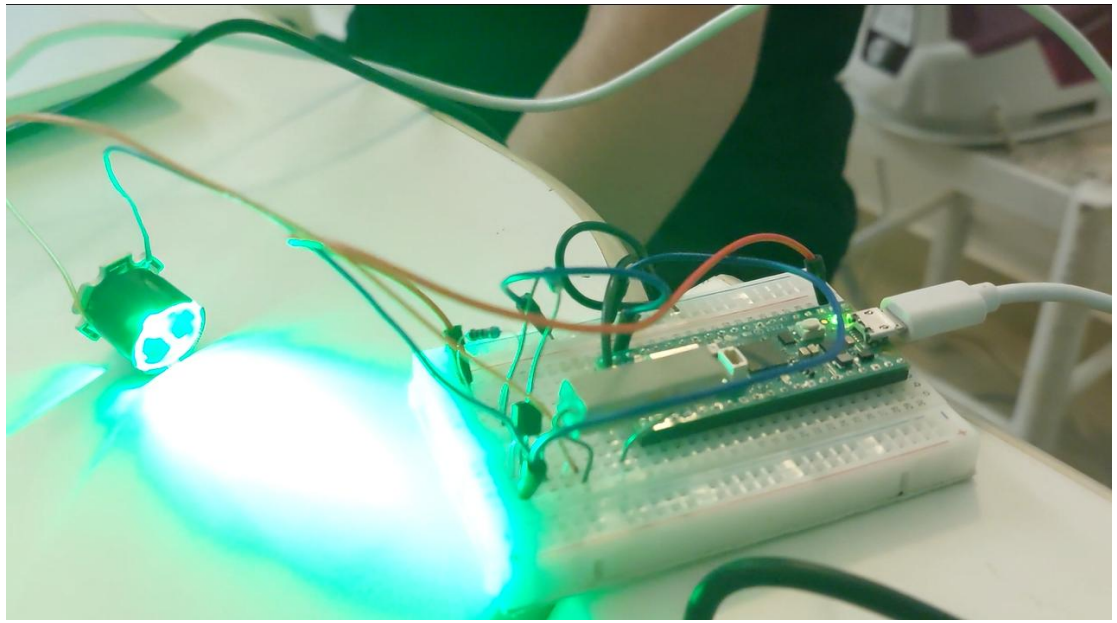


- Underwater communications practices haven’t evolved in over 50 years. Most divers use hand signals to transmit messages to each other, which requires both parties to be in each others line of sight.

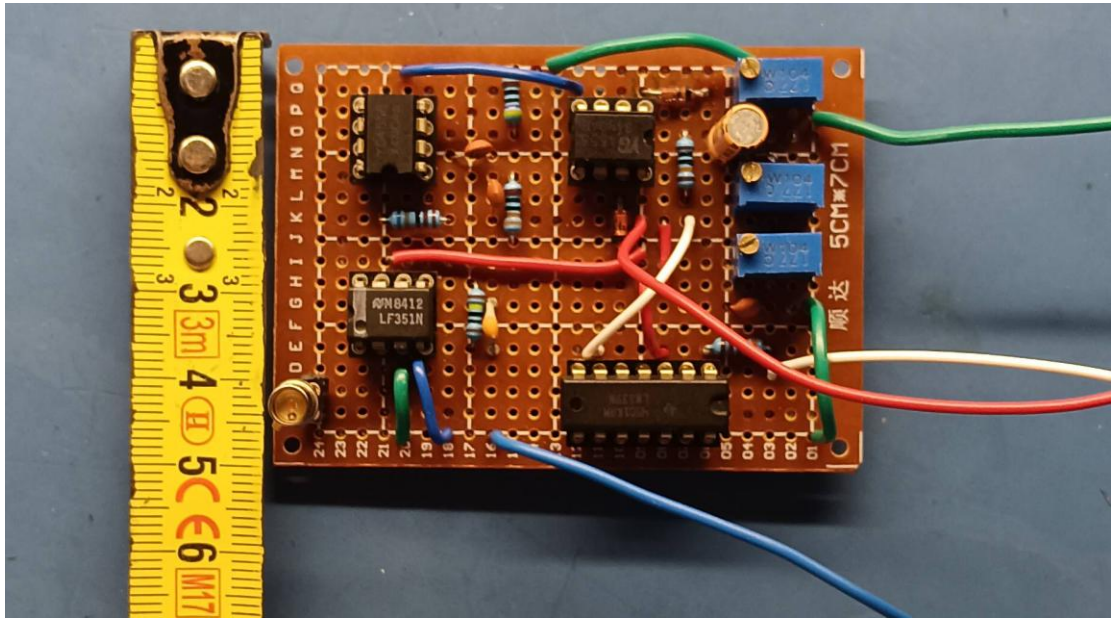
- The current usual methods are either **hard-wired communications** or **wireless communications** to communicate between divers or communications between boat and diver.

Technological solution – Overview

Our system will use light to send data underwater, and then convey any type of information to the diver.

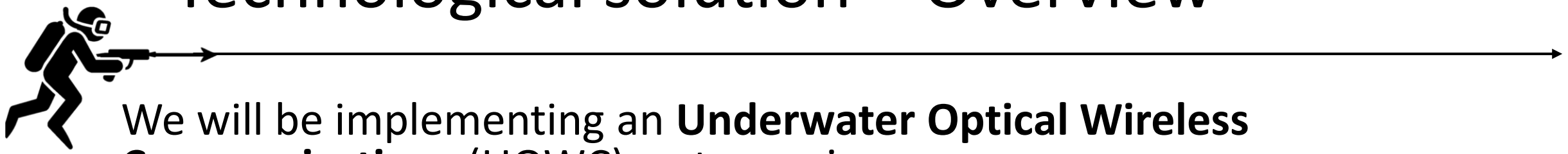


Transmitter



Receiver

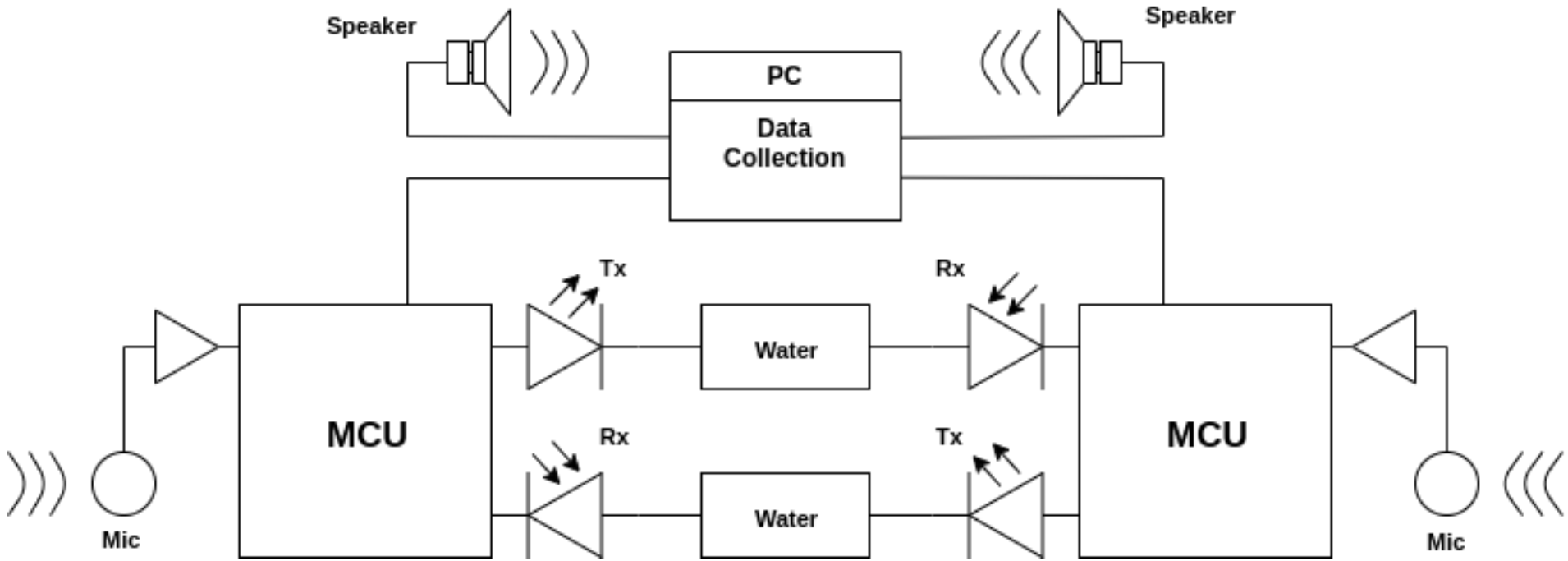
Technological solution – Overview



We will be implementing an **Underwater Optical Wireless Communications** (UOWC) system using:

- Microcontrolelr for signal processing.
- On-Off Keying as the modulation scheme.
- LED tuned to Blue/Green (≈525nm) light spectrum .
- Hamming(7,4) as the Error Correction Code algorithm.

Technological solution (Block Diagram)



Block Diagram of the prototype

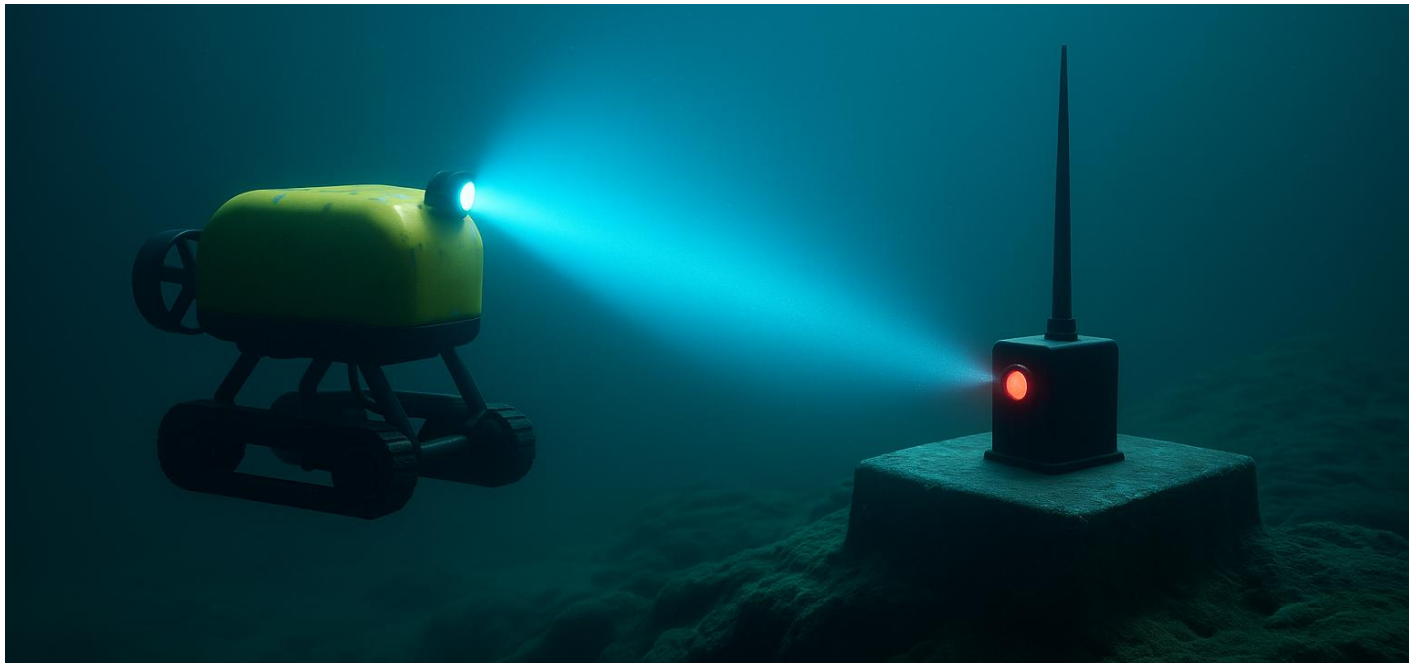
Solution beneficiaries

- Recreational Scuba Divers
- Diving Schools
- Rescue Missions
- Ocean Floor Exploration

Source: Image Bank

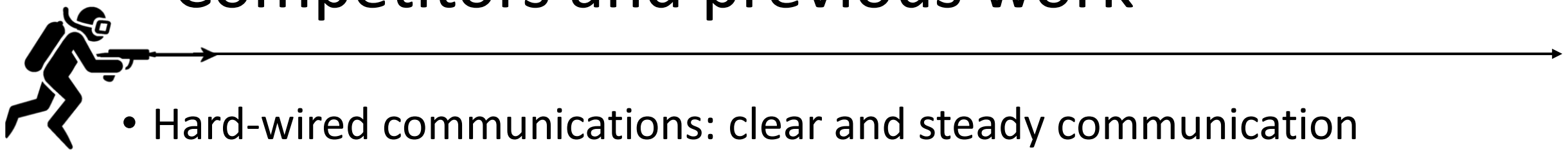
Solution beneficiaries

- It was also discussed with the DSOR group the possibility of using this technology when transmitting data between an autonomous underwater vehicle and its bay.



Source: AI Generated

Competitors and previous work



- Hard-wired communications: clear and steady communication without interference caused by water.
- Acoustic waves: very long range in deep waters, but low bandwidth, high latency, and high sensitivity to the environment.
- EM waves (in RF): quick data acquisition and transmission over short distances in clear waters. However, they are very easily attenuated.
- Hybrid systems.
- Use of 5G technologies and IoUT.
- LiFi.

Competitors and previous work

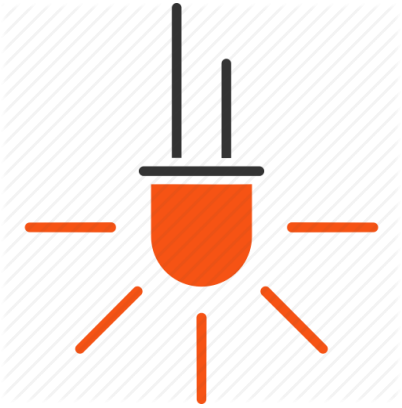
Both Hard-Wired and Wireless:

- https://oceantechnologysystems.com/
- https://diving.oceanreefgroup.com/underwater-communication/

Our main source of information:

https://pmc.ncbi.nlm.nih.gov/articles/PMC7219055/pdf/sensors-20-02261.pdf

Competitors and previous work



Li

Fi

LiFi is:

- fast
- Efficient
- low-latency

Its disadvantages are:

- its limited range
- light obstruction
- Line-Of-Sight requirement.

Team

Ricardo Rodrigues

Rodrigo Quina

Mauro Cordeiro

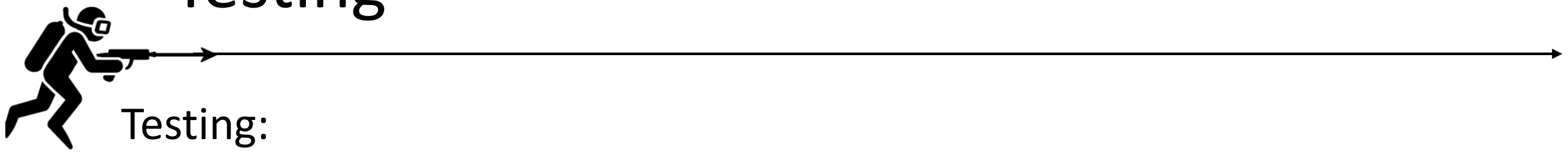
André Salvaterra

Afonso Frazão

Partners

- DSOR (Dynamical Systems and Ocean Robotics) from ISR;
- CPAS (Centro Português de Atividades Subaquáticas).

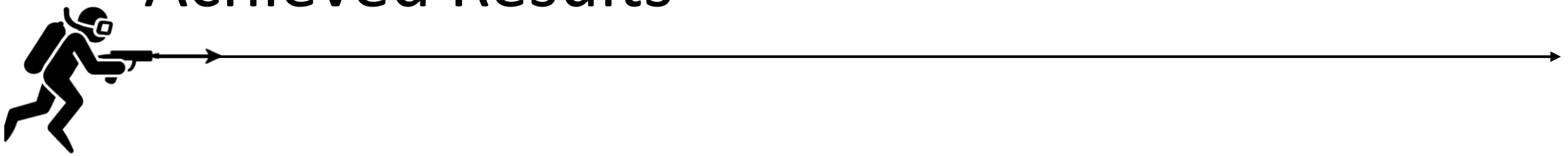
Testing



Testing:

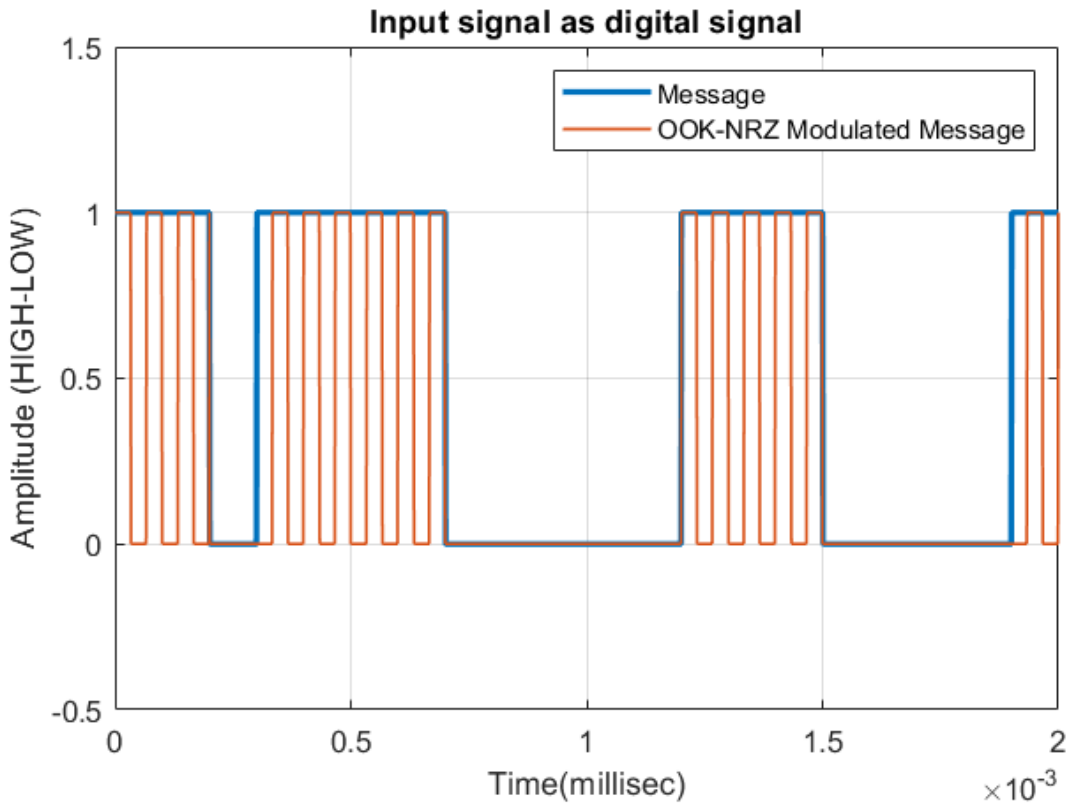
- Test sending and receiving simple modulated square wave (Hardware)
- Test sending and receiving simple previously known data (Software)
- Test data compression and error detection and correction (Software)
- Test range limitations outside water and inside water, with direct line of sight.
- Test different angles of transmitter and receiver.

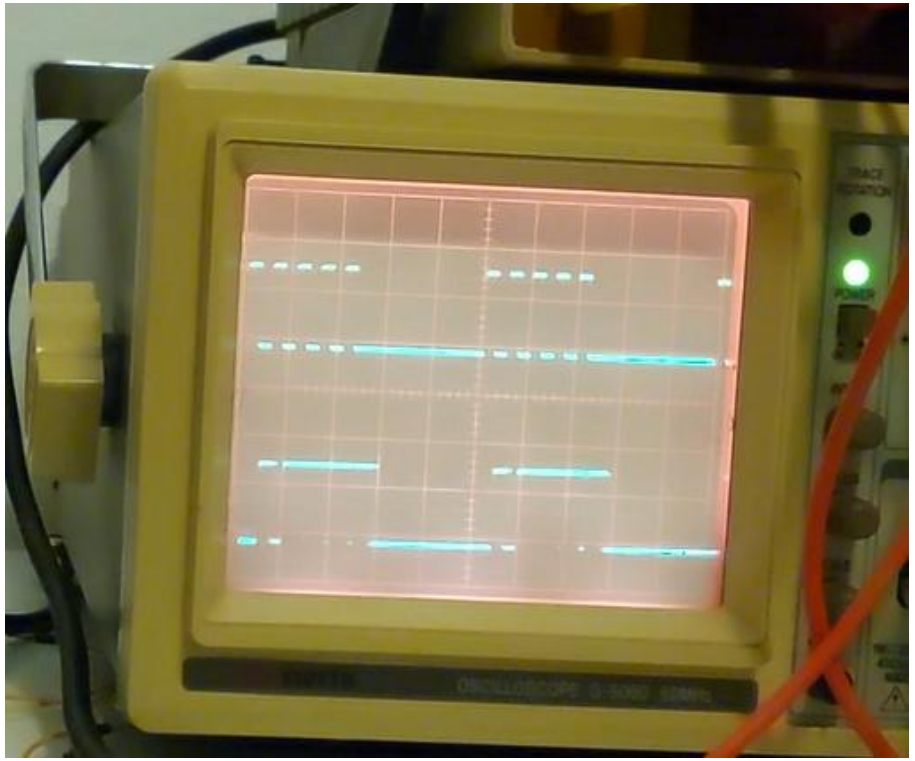
Achieved Results



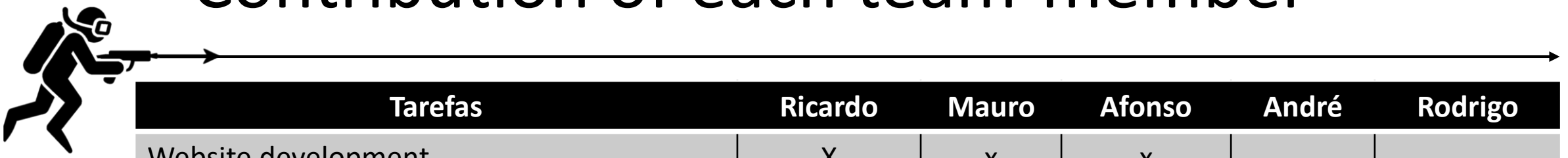
- Transmition Rate – 10 KHz (Modulating square wave)
- Bitrate of 2Kbps
- 1.5m – 0 bit error rate Outside water
- 90cm - 0 bit error rate Inside water (Max. tested range)

Achieved Results –Prototype





Contribution of each team-member

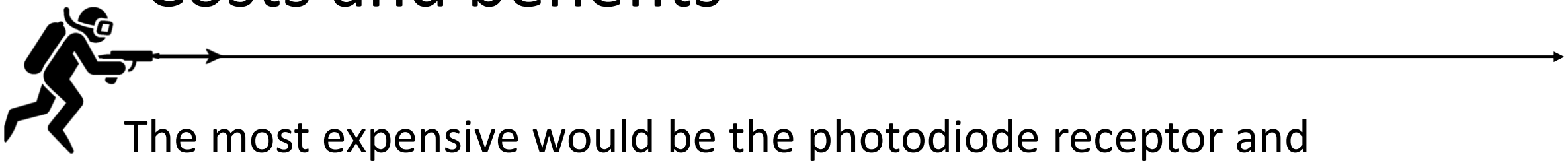


Tarefas	Ricardo	Mauro	Afonso	André	Rodrigo
Website development	X	x	x		
Hardware development		X	X	x	
Software development		x	X	X	
Literature search and reading	X	X	x	x	x
Presentation Elaboration	X	X	x	x	x
Finding partners	X		X		X
Interviewing	X		X	X	X
Blog writing					X
Poster design	x	x		x	X
Video editing	X				
Video recording	x	x	x	X	X

X – Big Contribution

x – Smaller Contribution

Costs and benefits



The most expensive would be the photodiode receptor and microcontroller, that can vary between 10€ - 50€. After that, all the other components are relatevely cheap.

This means that our solution can be affordable for divers, avoiding our competitors more expensive solutions.

Useful Links

Our Website - http://uowc.duckdns.org

Landing Page – http://uowc.duckdns.org/#home
Blog - http://uowc.duckdns.org/#blog-posts
Link to useful files (Video) - http://uowc.duckdns.org/html/files-page.html