GAPS-COMM

Cooperative Acoustic Positioning System

ELECOMP Capstone Design Project 2020-2021

Sponsoring Company:

iXblue Defense Systems Inc.
27 Wellington Rd
Lincoln, RI 02865
https://www.ixblue.com/

Company Overview:

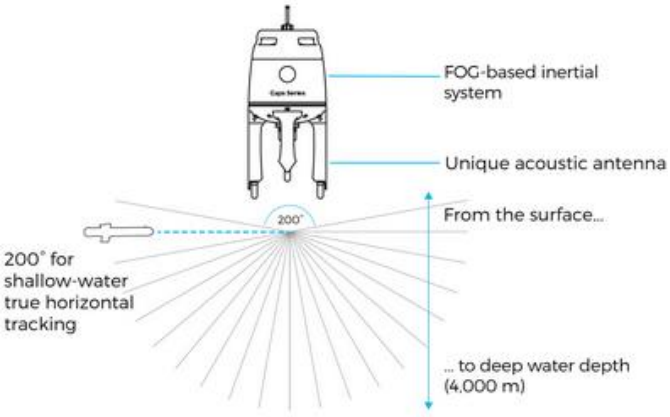
iXblue Defense Systems Inc. (iXDS) is a division of iXblue SAS, a French technology company specializing in inertial navigation systems (INS), photonics, acoustic positioning and communication, seabed mapping, drones, and several other areas. As a global leader in navigation and positioning technology, iXblue brings multidisciplinary expertise and solutions to the forefront of industrial practice. Located in Brest, France, the acoustic positioning division develops and manufactures a wide variety of equipment used in offshore operations, including acoustic releases, transponders, the Ultra-Short Baseline (USBL) positioning system GAPS (Global Acoustic Positioning System), and several other products. iXDS, located in Lincoln Rhode Island, has a large presence in the Autonomous Underwater Vehicle (AUV) market providing both Inertial Navigation Systems (INS), and acoustic positioning systems, such as the GAPS and acoustic transponders.

Technical Director:

Patrick Moran (URI '18)
Support Engineer
https://www.linkedin.com/in/patrick-moran-0b494010a/

Project Motivation:

The Global Acoustic Positioning System, or GAPS, combines the position and motion measurement accuracy of the iXblue PHINS INS with the acoustic positioning accuracy of a USBL system. The unique acoustic array design of the GAPS not only enhances its shallow water tracking performance, but also permits nearly omnidirectional acoustic positioning, allowing for horizontal area of operations up to 200°.



The embedded INS permits not only quick deployment, but also motion-compensated measurements ensuring high-fidelity acoustic positioning results.

The GAPS operates by emitting an acoustic ping to an acoustic transponder and awaiting a response. The time of arrival of the response ping at each of the four hydrophones is then measured and used to derive the approximate position of the beacon, similar to a GPS. Typically used in survey operations, this method of acoustic positioning allows a vessel to monitor an underwater vehicle or other asset. The GAPS can track over 40 beacons at a time by using different combinations of interrogation and reply codes.

Currently GAPS are configured by an operator based on the different acoustic beacons being used and the mission requirements. In cases where there is a large offshore operation that includes multiple systems, **each is configured and operates individually**. This project proposes to provide a simple solution using the GAPS technology as is, leveraging the existing product capabilities to add in a software control layer, and a hardware/ software communication layer.

Anticipated Best Outcome:

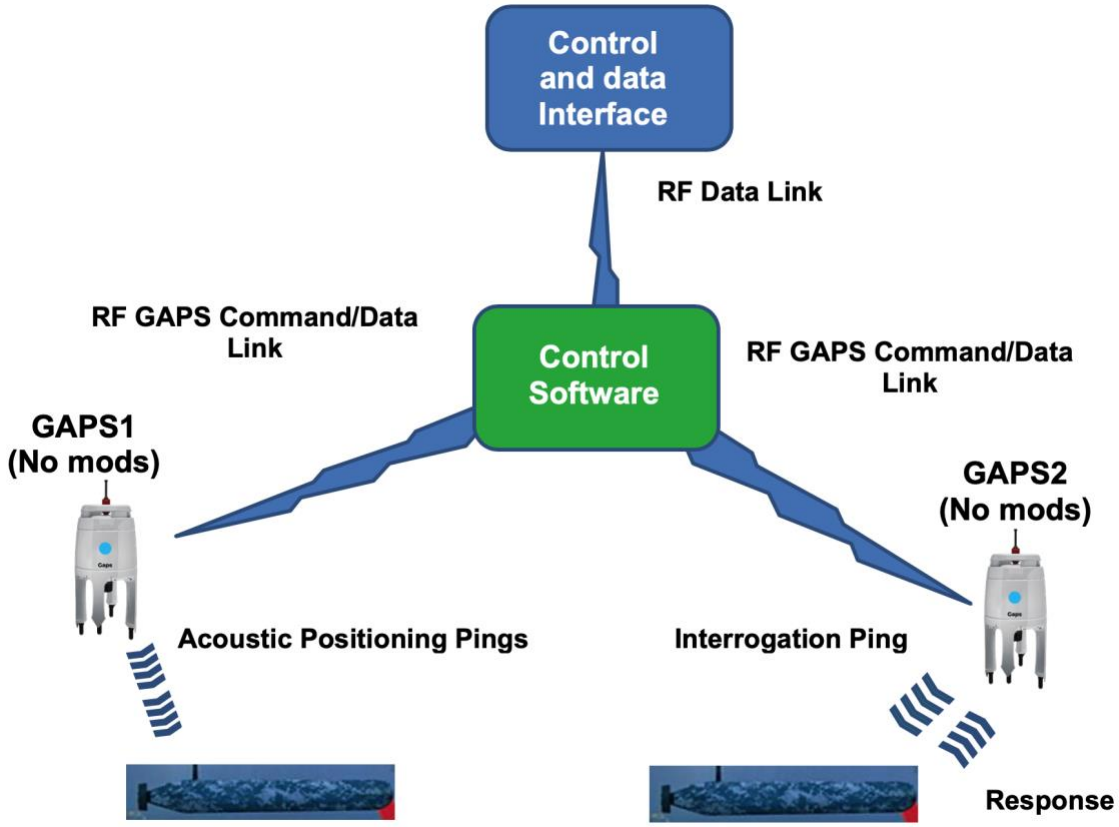
The project will culminate in the delivery of a software and hardware prototype system for the cooperative operation of GAPS. Adequate documentation of all software and hardware such that the project can be expanded upon or drawn from in the future should be updated periodically throughout the project. The anticipated best outcome is to perform hardware in the loop testing and validation of the prototype with two GAPS systems in water. The following deliverables will be developed through the course of the project:

- A prototype to network and control multiple GAPS systems
- Software design document
- Software documentation detailing the operation of the prototype software
- Hardware documentation detailing the physical system components
- Test data
- A final report covering all results, test data, project progress, and suggested next steps

Project Details:

The GAPS ethernet connection, combined with high bandwidth, long range, radio systems, allows for multiple units to be installed on separate platforms, connected on a common network, and controlled through a singular point. This provides the basis for development. The software will combine acoustic positioning information from multiple GAPS units to control (start/stop) tracking operations, identify the appropriate unit to interrogate each target based on proximity, and provide a singular condensed output of all positioning and tracking information across the network. The final solution will allow the user to configure and operate multiple GAPS units physically separated but connected via a singular network, while also automating tracking of targets in overlapping areas of acoustic coverage.

System Block Diagram



Team Breakdown

The team will be directed by iXDS personnel, specifically Support Engineer Patrick Moran, URI '18. All team members will be involved in the initial prototype requirements definitions, architecture description, and test development. Guidance on product technical matters will also be provided from iXblue personnel.

- **Systems engineering** tasks will be split between ELE and CPE students
- **Software design** tasks will be handled primarily by CPE students, EE students will support, work-load permitting
- **Hardware design** tasks will be handled by ELE students
- **Testing** tasks will be handled based on functionality being tested

Systems Engineering Tasks (ELE/CPE):

- Hardware Functional requirements documentation
- Defining software functionality, inputs and outputs
- Thorough software documentation
- Define required system tests

Software Design Tasks (CPE):

- Develop the control software and include functions to:
  - Send individual commands to each GAPS unit
  - Decode GAPS messages
  - Determine when to activate/deactivate acoustic tracking of each GAPS unit
  - Store all position information received from each GAPS
  - Output a single data stream with relevant information
  - Establish connections to each GAPS system
  - Monitor network health

Hardware Design Tasks (ELE):

- Design and prototype remote on/off capability
- Generate mechanical footprint
- Generate a bill of materials for system
- Identify power requirements of system

Testing Tasks (ELE/CPE):

(Testing tasks are focused around simulated testing and hardware in the loop testing)

- Software functionality with simulated data
- Software functionality with recorded field data
- Remote system on/off
- Resources permitting field testing on a vessel
- Communications between two GAPS systems

Prototype Field Testing (ELE/CPE):

- In water testing with two GAPS and two beacons
- Performance qualification
- Data recording for performance analysis

Final Project Report (ELE/CPE):

- Comprehensive report detailing project
- Details on what and how goals were accomplished
- Immediate next step recommendations for prototype

Composition of Team:

1 Electrical Engineer & 2 Computer Engineers

Skills Required:

Electrical Engineering Skills Required:

- Digital Circuit Design
- Electronics
- Experience with RF communication and related hardware
- Experience with single-board computers (e.g. Arduino, Raspberry Pi)

Computer Engineering Skills Required:

- Proficiency with at least one object-oriented programming language
- Communication Protocols (e.g. I2C, SPI, MQTT)
- Interfacing with sensors/actuators
- Experience using single-board computers (e.g. Arduino, Raspberry Pi)
- Desktop/Web Application Development
- Database Design and Data Storage
- Computer Networking

Anticipated Best Outcome's Impact on Company's Business, and Economic Impact

The system described in this proposal has potential to reduce time spent during configuration of the beacons and their management. Additionally, the ability to monitor and control multiple beacons would allow iXblue Defense to expand their product use-cases. Such improvements could result in both cost-savings and increased business for ixBlue Defense as well as iXblue SAS.

Broader Implications of the Best Outcome on the Company's Industry:

As the IoT market continues to grow, the importance of data collection and processing cannot be overstated. Intercommunication of devices allows for greater and more efficient usage. The creation of such a system would further the growth of IoT technologies and their usage in the numerous industries for which iXblue develops solutions.