Precise Point Positioning GNSS Receiver

ELECOMP Capstone Design Project 2020-2021

Sponsoring Company:

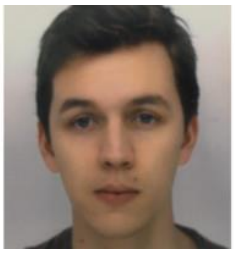
iXblue Defense Systems, Inc.
1580 Lincoln St, Denver CO
https://www.ixblue.com/

Company Overview:

iXblue Inc., based out of Denver, CO, 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. iXblue Inc. provides enhanced R&D, sales and support to customers and prospects in the North American region, focused on the civilian market. The team works for instance to provide navigation solution for autonomous vehicles, drones, mobile mapping, survey and many more.

Technical Director:

Guirec Morvant
Software Engineer



Project Motivation:

Most of iXblue products, including Inertial Navigation Systems (INS), depends highly on Global Navigation Satellite Systems (GNSS) such as GPS, GALILEO or GLONASS to provide its position to a user. Depending on the application, different level of precision in positioning are expected.

GNSS have multiple operating modes that enable to reach various levels of precision of localization from meter range to centimeter. The natural operating mode, that uses only satellites emitted signals, allows to reach a level of precision of a few meters. To reach the highest levels, additional information may be used. For instance, Satellite-Based Augmented System (SBAS) solution uses broadcasted information in some part of the world to have a localization error of less than a meter. Another solution, Real Time Kinematic (RTK), use information from a nearby base station that helps to correct the user position and reach the centimeter level of precision.

Those solutions are used as standard today but have strong requirements. A new form of correction is predicted to be the next step in precise positioning: Precise Point Positioning with Ambiguity Resolution (PPP – AR). The biggest drawback of PPP used to be the time it needed (~30mn) to achieve a precise localization, but research papers have shown that with the multiplication of information available from satellites, broadcasted corrections, and the improvement of receivers, it would be realistic to obtain quickly a centimetric level of precision without relying on a nearby base station.

From this statement, iXblue goal is to evaluate this technology, and if it demonstrates the expected performances in real life conditions to integrate it in iXblue products.

Anticipated Best Outcome:

The anticipated best outcome consists in the delivery of an integrated electronical board able to compute a PPP-AR solution that could correct the position of the inertial navigation solution of existing iXblue products in real-time or postprocessing.

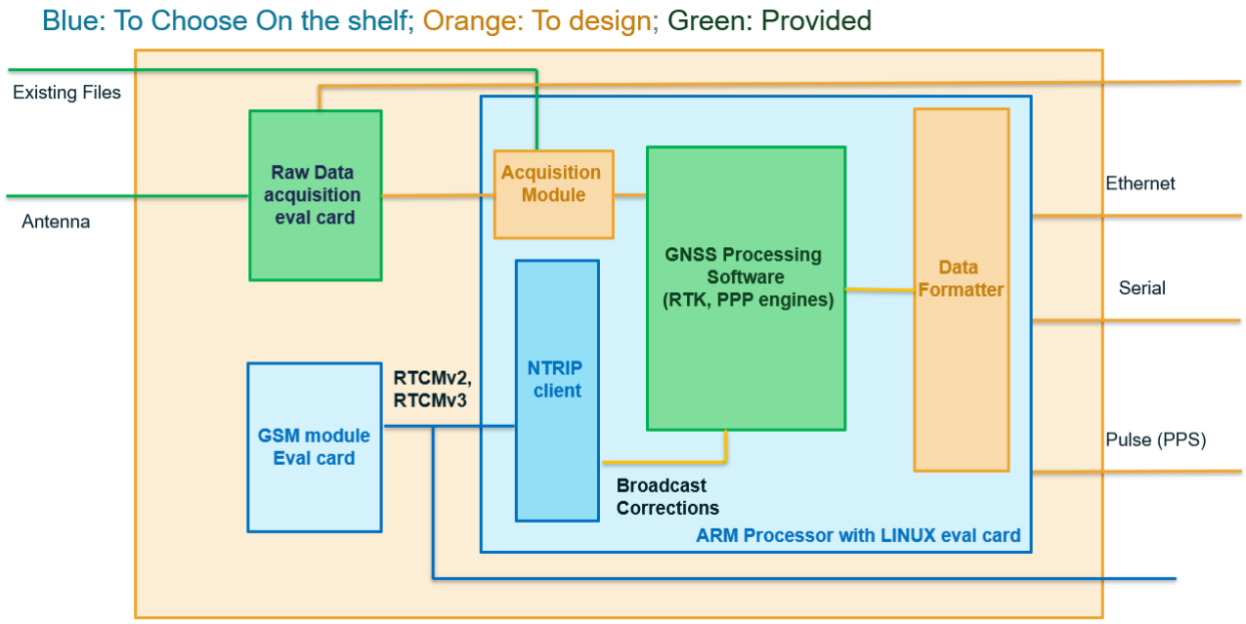
Adequate documentation of all software and hardware such that the project can be expanded upon or drawn from in the future should be updated periodically throughout the project. The following deliverables will be developed through the course of the project:

- GNSS receiver embedding a PPP software for live and offline processing
- Software design document
- Software documentation detailing the operation of the software
- Hardware documentation detailing the physical system components and justification of the components choices
- Test strategy
- A final report covering all results, test data, project progress, and suggested next steps

Project Details:

The main goal is to dispose of a board able to compute a PPP-AR solution. To do so, an acquisition module for antenna signals or existing files is necessary, as well as a GSM module evaluation card for the broadcasted corrections. Then, to integrate the GNSS processing software, an ARM processor (type IMX) will be used to integrate the broadcasted corrections and compute signals to obtain a precise position solution. The solution will then be output on classic formats (Ethernet, Serial) for a possible integration to iXblue. An iterative process is considered with key steps to validate the progress in the process.
To create this system, the team will be guided to design or choose on the shelf some submodules, while other submodules will be provided.

System Block Diagram



Team Breakdown

The team will be directed by iXblue Inc. personnel, specifically software engineer Guirec Morvant. 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, ELE students will support, workload 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):

- Choosing the right GSM and ARM modules based on the provided specifications
- Thorough software and documentation
- Define test strategy

Software Design Tasks (CPE):

- Installation of Linux on the ARM and the already existing components (NTRIP Client, GNSS Processing software)
- Design of the acquisition module component (either from the acquisition card of from existing file for simulation and debug)
- Design of the output interface (Data Formatter)

Hardware Design Tasks (ELE):

- Assemble the eval boards of the chosen modules (GSM, ARM, data acquisition + connectors) on a 3-D printed box
- Design an antenna splitter (bias-T)

Lab Testing Tasks (ELE/CPE):

(Data vector will be provided by iXblue)

- Design a PC simulator to send data to the ARM board without the acquisition board
- Software functionality with simulated data
- Software functionality with recorded field data
- Compare the performance of the antenna splitter with commercially available solutions
- Hardware functionality with recorded field data

Field Testing (ELE/CPE):

- Hardware functionality with side by side comparison with on the shelf solution on a car
- 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 product development

Composition of Team:

1-2 Electrical Engineers & 2 Computer Engineers

Skills Required:

Electrical Engineering Skills Required:

- Digital Circuit Design
- Electronics
- Knowledge on RF communication and related hardware

Computer Engineering Skills Required:

- C++
- Linux
- Communication Protocols (USB, TCP/IP, serial)
- Experience using ARM processors (e.g. IMX 6)
- If possible: Desktop/Web Application Development

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

The system described in this proposal will allow to verify the benefit from a PPP-AR solution for industrial application. It has potential to be the beginning of a full product that could provide a very accurate localization solution without any infrastructure, which could benefit the company to address markets with adequate navigation solution. For instance, those that could not benefit from base station nearby for RTK such as wide mapping or even boats at sea would widely benefit from such a solution.

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

One of the main goals of iXblue is to stay up to date with the cutting-edge technologies and innovation. As PPP-AR is anticipated to be one of the major next steps in localization technology, it is important for the company to be able to have its own expertise on the subject. This project will allow us to understand better the stakes of PPP-AR and thus help to keep updating our products.