Intel Embedded Systems Competition 2016

Hydrus – Autonomous Drone for Hydrologic Monitoring

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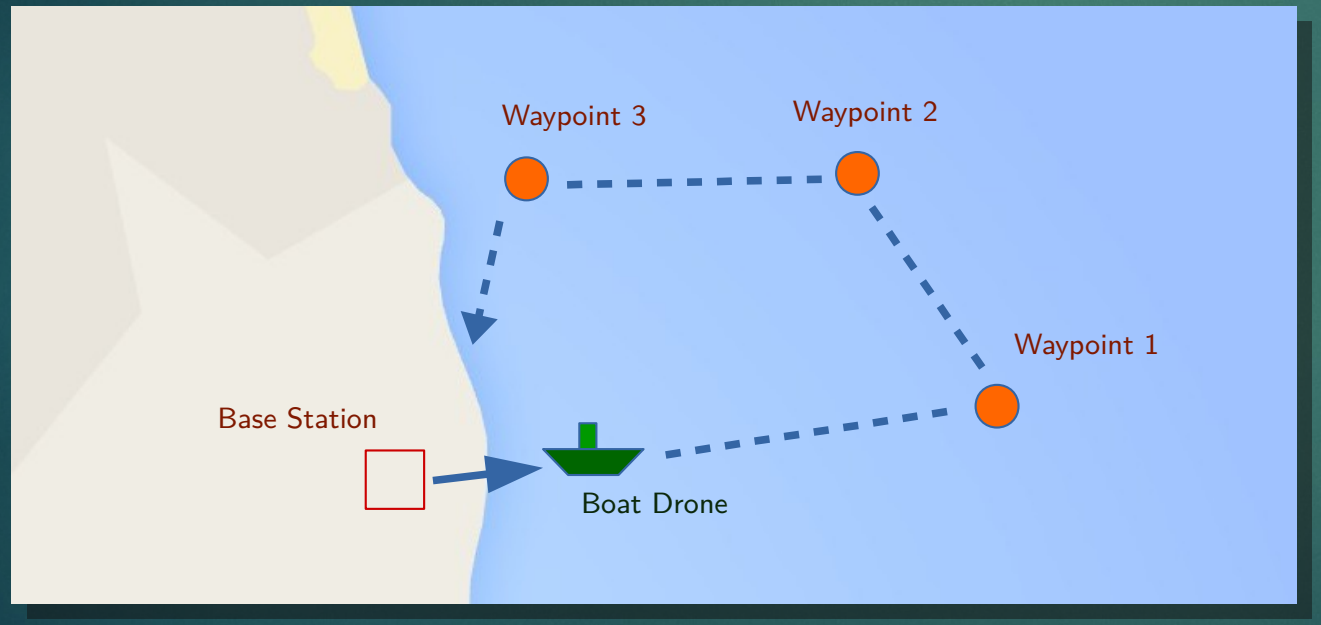
Organization

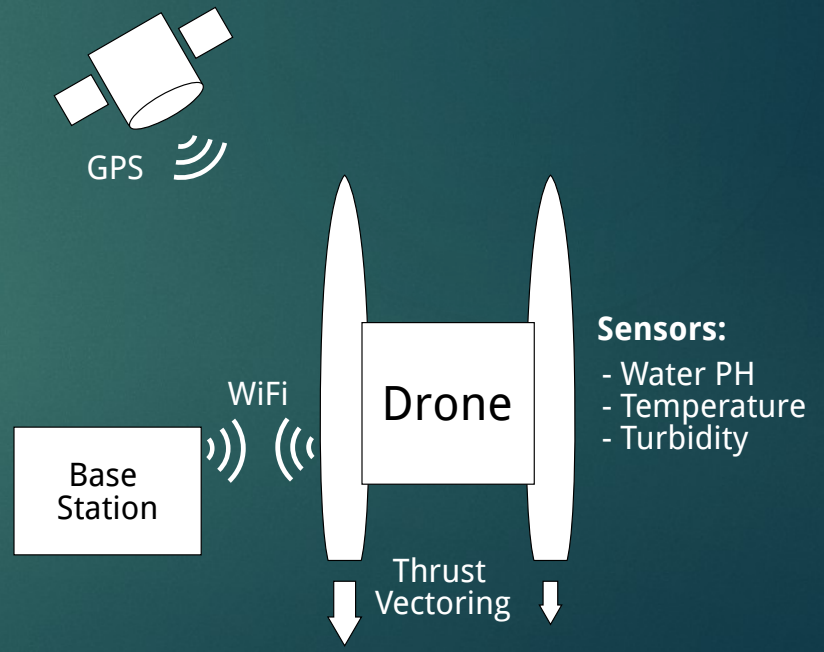
Promotion

Sponsorship

The Hydrus Project

- An autonomous boat drone for data acquisition, and water quality sensing.
- Able to navigate autonomously, via GPS, and collect water quality data along the way.





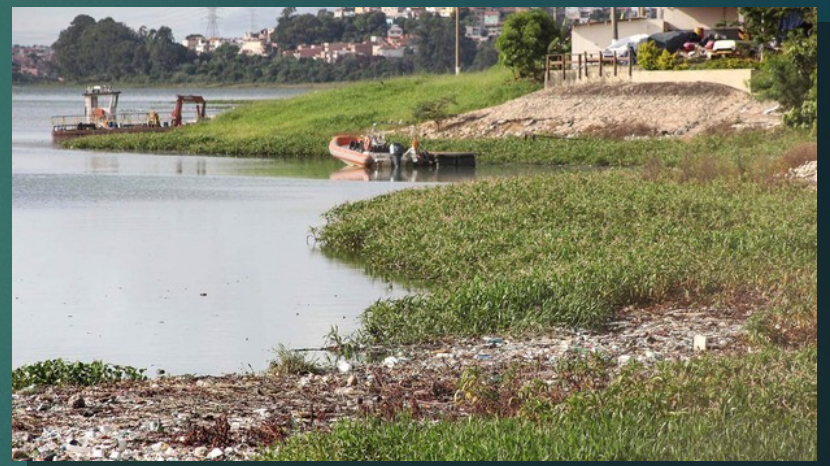
Why is it important?

- 65% of sewage in Brazil is dumped untreated (IGBE + SNIS 2014)
- Manual monitoring of water in reservoirs is expensive, slow, and sparse.
- Advances in technology and lowering costs can help solve problems more easily.
- Our drone can...

    Increase the number of measurements.

    Geotag all measurements by default.

Open sewage in João Pessoa, PB
Source: goo.gl/34XWrf



Garbage floating in a SP reservoir
Source: goo.gl/SnBXYp

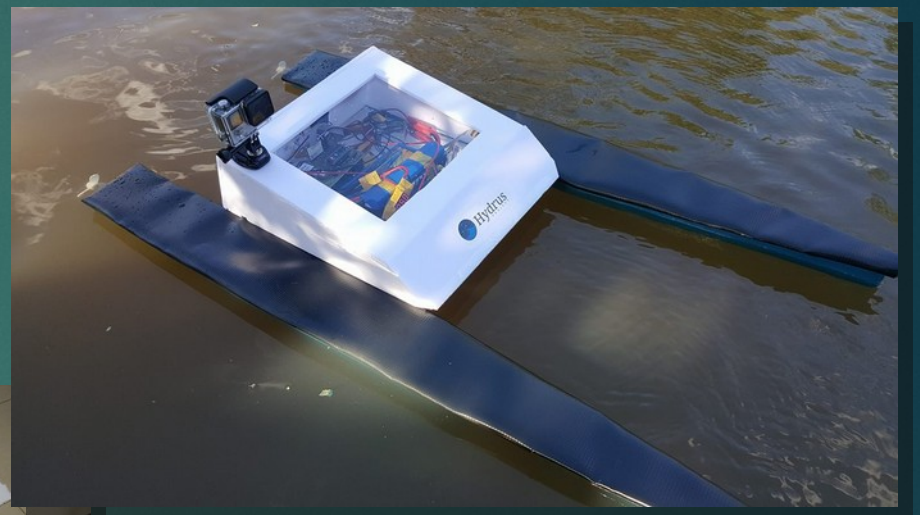
Boat Frame

- We decided to build our own boat from scratch.
- Laminated fiberglass on a custom mold.
- Adequate size and build for our application.

The plug

The mold

The hulls

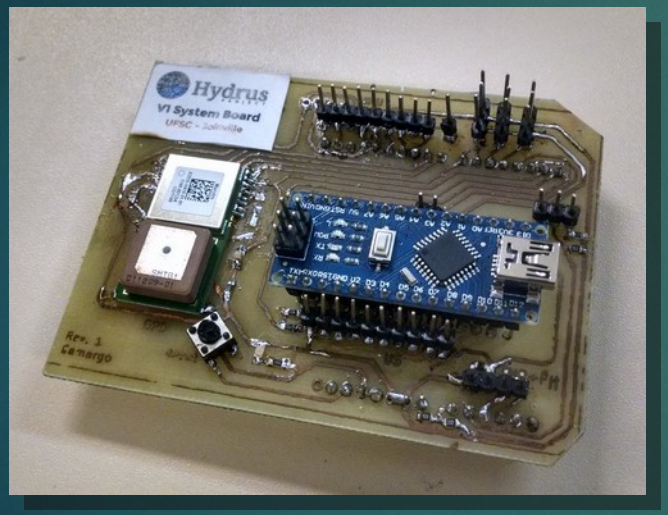


Hydrus V1

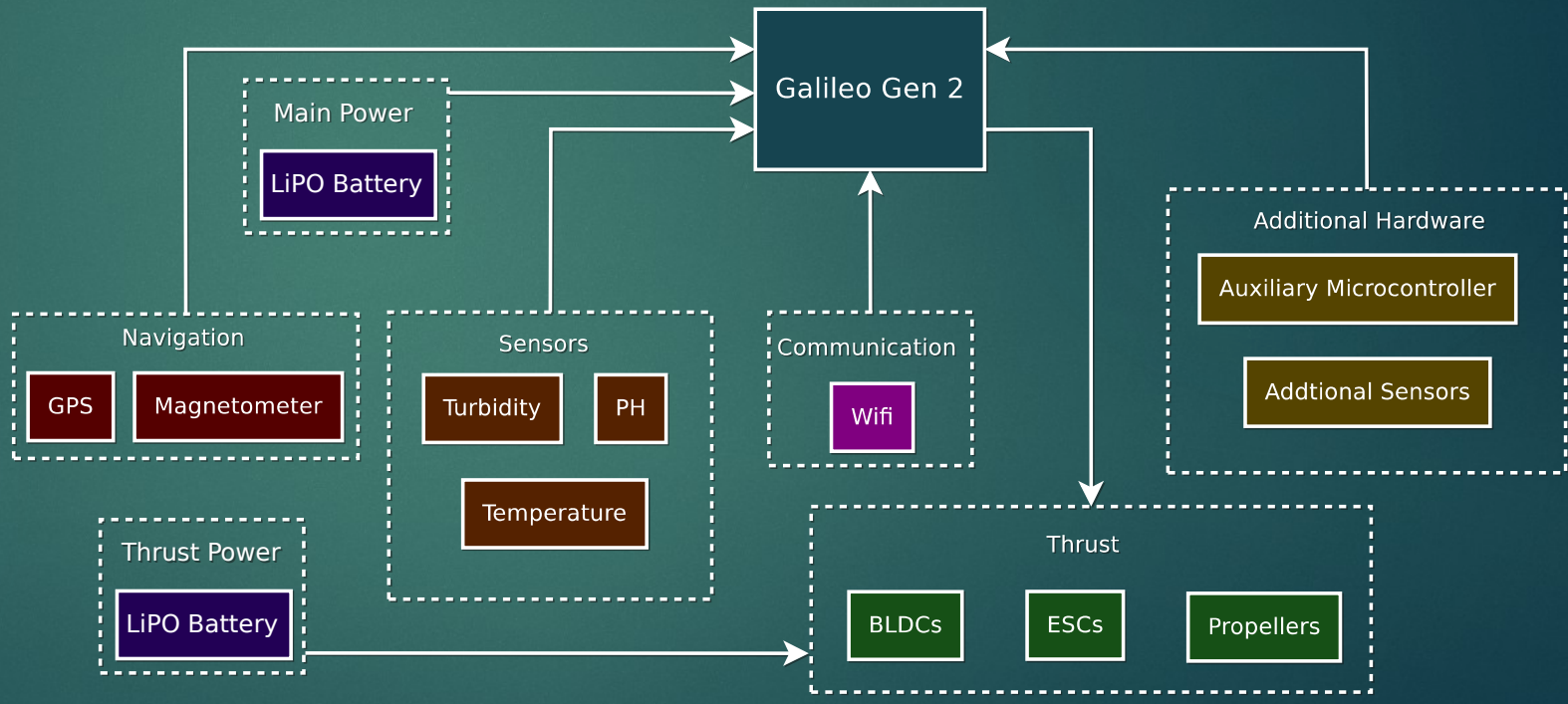
“From zero to boat in a couple of months”

Hardware

- GPS and magnetometer for navigation.
- WiFi module for base communication.
- PH, turbidity, and temperature sensors.
- Additional sensors can be connected to auxiliary µC.

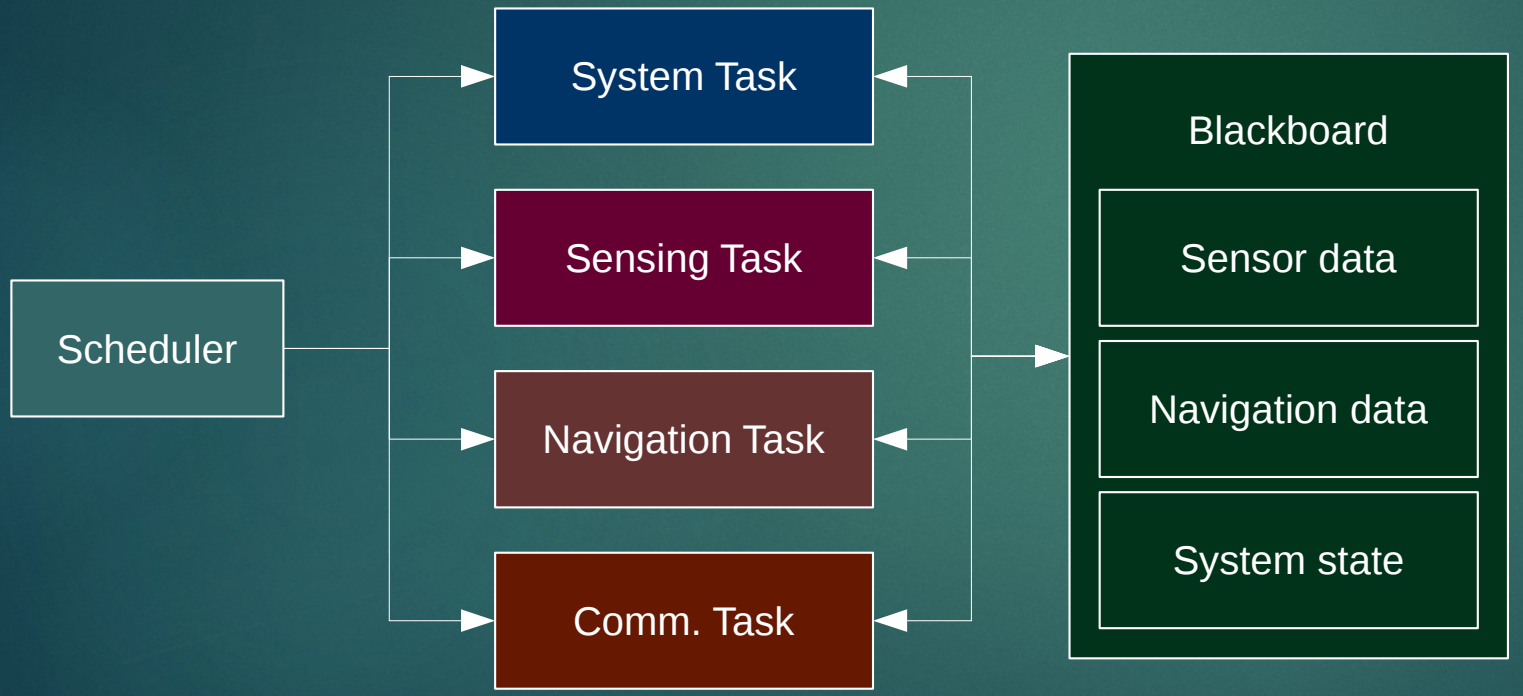


Our custom Galileo shield



Software

- Custom built C / C++ firmware, with standard IoT image.
- Cyclic executive scheduler + blackboard architecture.

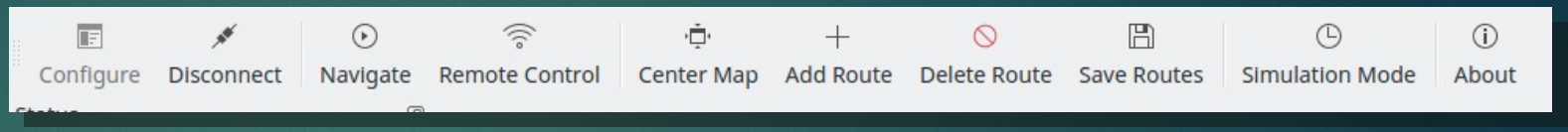


Task	Execute (A)	Execute (B)	Period
System	✓	✓	0.02s
Sense	✓	✓	0.02s
Nav	✓		0.04s
Comm		✓	0.04s

Cyclic task Schedule. Major period is 0.04s

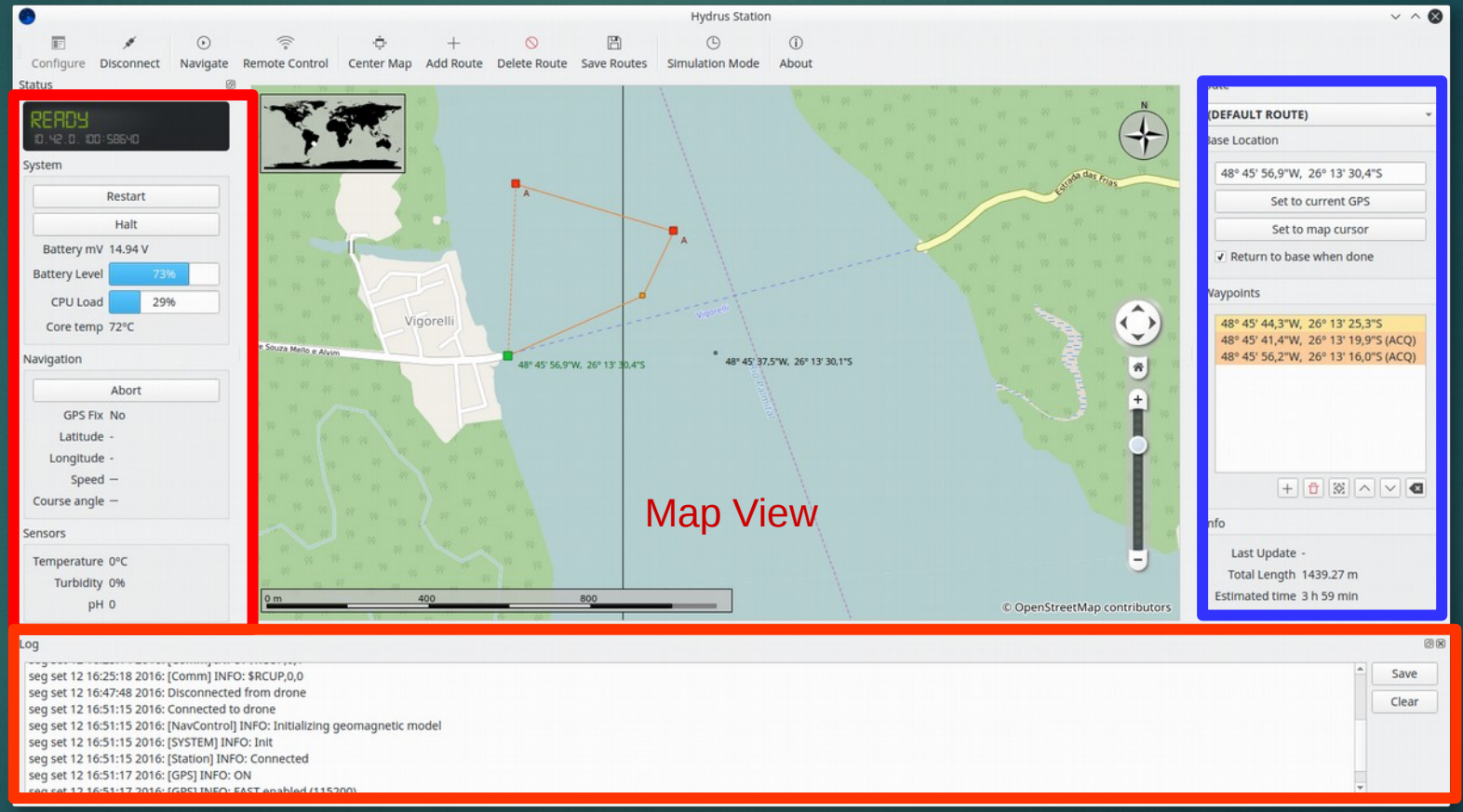
Base Station Software

Main toolbar



Drone status

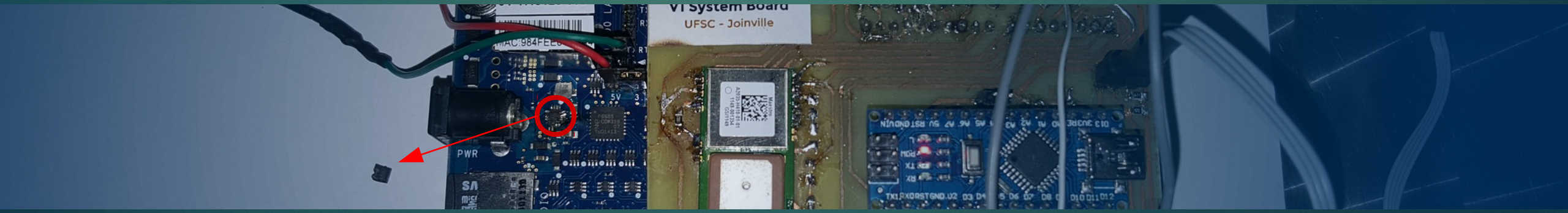
Route planner



Log viewer

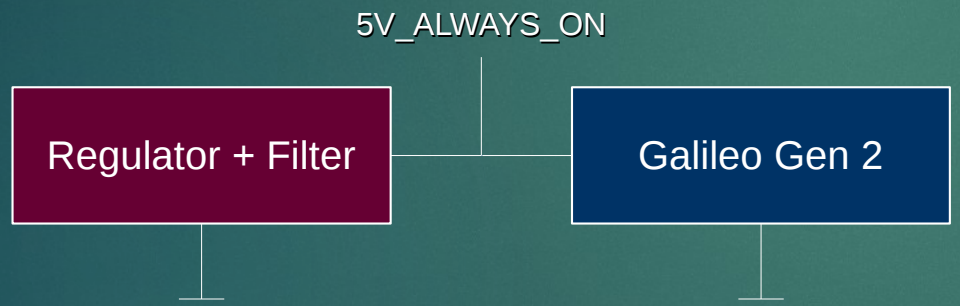
Technical issues

- We found the Galileo Gen 2 board to be very sensitive.
  - Inadequate inrush current protection: we had the regulator catch fire because we plugged the board to a lithium battery (14.5V).
  - There should be a separate I2C bus for the onboard peripherals: any interference would bring the sketch to a halt.
  - We bricked one probably because the IOREF jumper was loose...

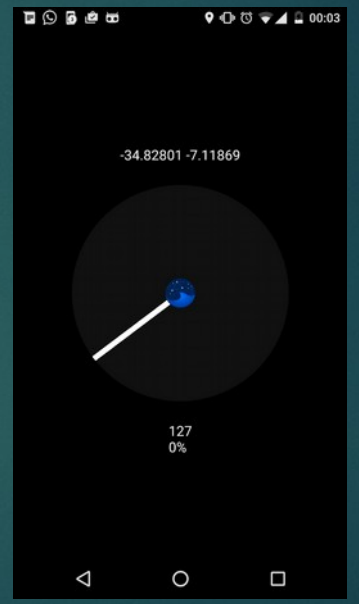


Workarounds

- A couple of boards were brought back to life by supplying +5V directly.
- We created a GPS-publisher phone app for situations it was hard to get the GPS module to fix to the satellites.
  - Overcast weather, old almanac data, etc



Simple solution for blownup regulator (U6)



Helper Android application

Why the project is innovative?

- A handmade, low-cost boat drone that can navigate autonomously, and collect data on water quality along the way.
- Modular hardware and software. Custom physical frame.
- Our drone is a framework that can be easily extended to support additional sensors and applications.

Item	Price (USD)
Boat frame	$60.00
Battery + Powertrain	$51.00
Galileo Gen 2	$77.00
Sensors and Modules	$129.00
Total	$317.00

Results and Future Plans

- The drone is able to reach programmed waypoints and navigate correctly.
- The companion application allows the user to plot collected data spatially.
- We plan to study the usage of the boat for sonar bathymetry applications.
- We also want to investigate additional energy sources, such as solar.

Plot of collected temperature data on a mock route

Thank you for your attention!

Questions?