RDE Avalanche transmitter for beacon tests

Sponsored by: Michal Podhradsky Joe Kiniry
Galois, Inc.
https://galois.com/

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Background and Motivation

Galois has successfully used Rigorous Digital Engineering (RDE) practices for development of complex cyber-physical systems relevant for the national security, from a vehicle demonstrator that thwarts cyberattacks[1], to the next generation reconfigurable optical modem for various Low-Earth-Orbit (LEO) constellations. As the RDE tooling and practices mature, we strive to demonstrate that RDE can be used not only to provide secure systems, but also to deliver a consumer-grade product to the market faster, cheaper and in higher quality than with traditional engineering practices.

Objectives

An avalanche transceiver is an essential piece of equipment for winter outdoor recreation. In case of an avalanche, a properly trained rescuer can locate a victim even under several feet of snow, when both the victim and a rescuer have a transceiver and can operate them efficiently. To facilitate training, often old or borrowed transceivers are used, because transceivers are rather expensive. However, to practice complex multi-burial scenarios several old or borrowed transceivers are needed, which is difficult to coordinate.

To alleviate this problem, we would like the students to develop a cheap avalanche transmitter that can be easily assembled and used for training purposes. We seek to use this project as an example of applying RDE techniques on a small scale project, highlighting the benefits of RDE beyond critical infrastructure and security critical devices.

Requirements

The relevant technical requirements for the transmitter are captured in the ETSI EN 300 718-1 standard.[2] We expect the students to develop a transmitter for testing search & rescue scenarios with commercial avalanche transceivers. Our requirements are:

[1] Currently on display at National Cryptologic Museum
[2] Freely available at https://nhqc3s.hq.nato.int/Apps/ETSI/specs/EN_30071801v010201p.pdf

- a transmitter must be broadcasting at 457kHz
- students must review current FCC regulations of the transmitter frequency (if any)
- the transmitter must be enclosed in an IP65 like enclosure (must survive in snow and cold)
- the transmitter must be detectable by commercial transceivers at up to 30 meters, but not beyond 70 meters
- the transmitter hardware and enclosure should cost less than $100 a piece (the cheaper the better)
- the transmitter must be broadcasting the following pattern at 1Hz as defined by the aforementioned standard (see Figure 1)

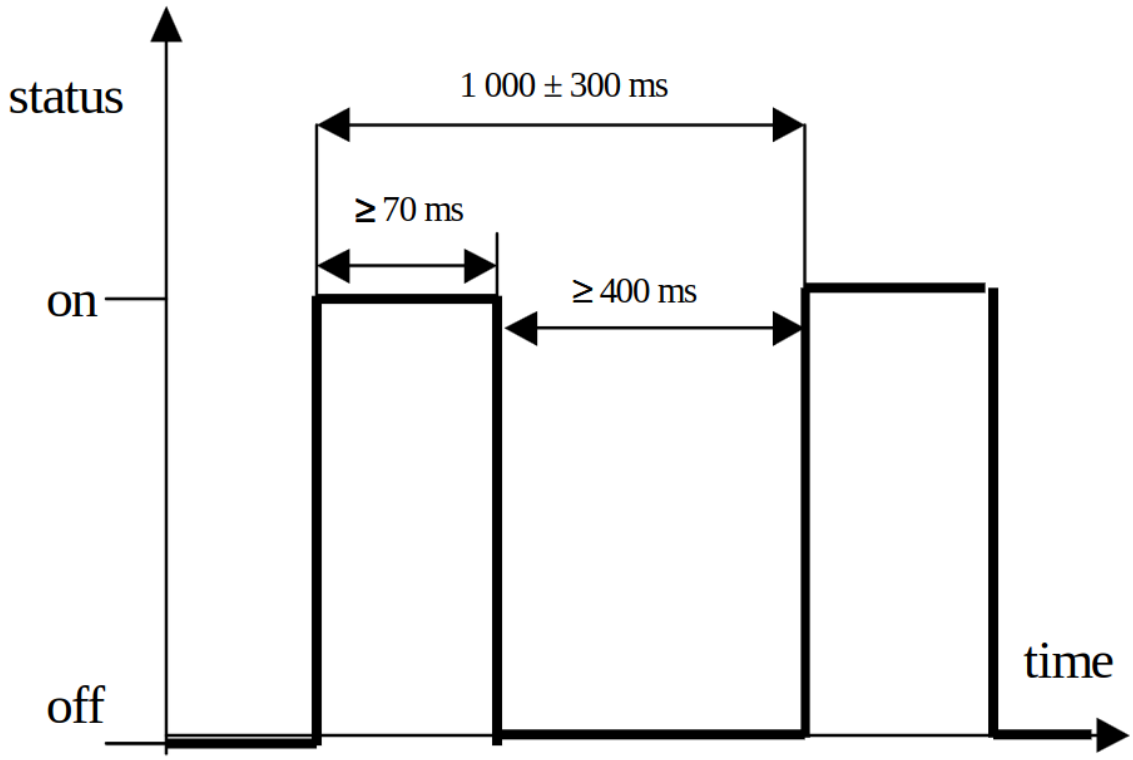

Figure 1

Deliverables

With the help from Galois experts, follow the RDE process throughout the project. While the process should be tailored to the team, we expect roughly the following:

- follow the best practices for version control (github)
- create structured, actionable requirements, that can be traced throughout the design
- explore the variation points in the design, and evaluate different trade-offs such as cost, size, and complexity
- use EDA and CAD tools for PCB design, power estimation, analog and digital simulation
- deliver a working prototype that satisfies all the requirements
- provide a Bill-Of-Materials (BOM), and thorough documentation for easy replication

Note that this work is fully open source, and the resulting prototype is intended to be used and replicated by the wider outdoor community. We are open to publishing the project on https://www.crowdsupply.com/ if the team delivers compelling results and is interested in pushing the product to a small scale production.

Suggested Skills

We believe that this capstone fits squarely into PSU's curriculum, so no special student skills are needed besides being excited about embedded hardware and cyber physical systems in general, and being willing to learn the state-of-the-art industry practices.