Model Rocket Telemetry and Launch Control

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Research Project Presentation
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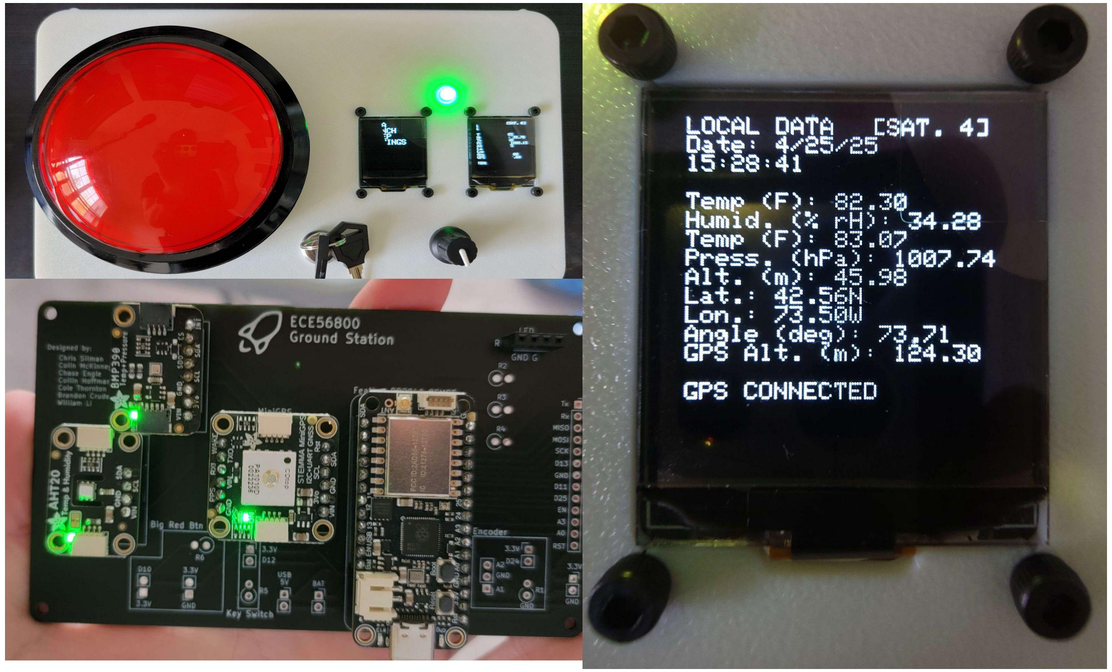
Project Goals

- Create two embedded systems for model rocketry: a ground station and flight computer, linked by RF, to control launch and collect and transmit flight telemetry.

- Outperform an existing consumer-grade product (JollyLogic) at a lower cost than an existing professional-grade product (Multitronix).



Ground: Sensors, UI, Custom PCB

Flight: MCU, Sensors, Rocket

Methodology: Hardware and Software

Hardware

- MCUs: Adafruit RP2040 Feathers w/ STEMMA QT and LoRa 915 MHz radio.
- 915 MHz RF is within unlicensed ISM band (FCC Part 15). Low power, long range.
- Ground: sensors, user interface, safety switch, launch control, antenna, custom PCB and housing.
- Flight: sensors, antenna, ignition control, parachute, custom payload housing.

Software

- Used C++/Arduino IDE instead of MicroPython, due to RF library.
- Modular class structure for reusability.
- Rocket and ground station operate as a linked state machine. Synchronous state transitions.
- DOF sensor information used to detect flight status changes.
- One-shot timer used to detect ignition failures.

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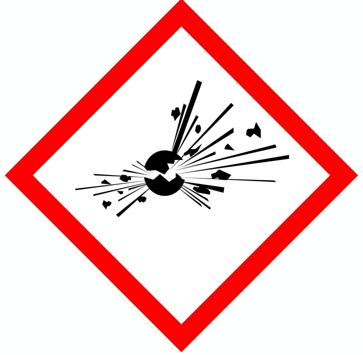
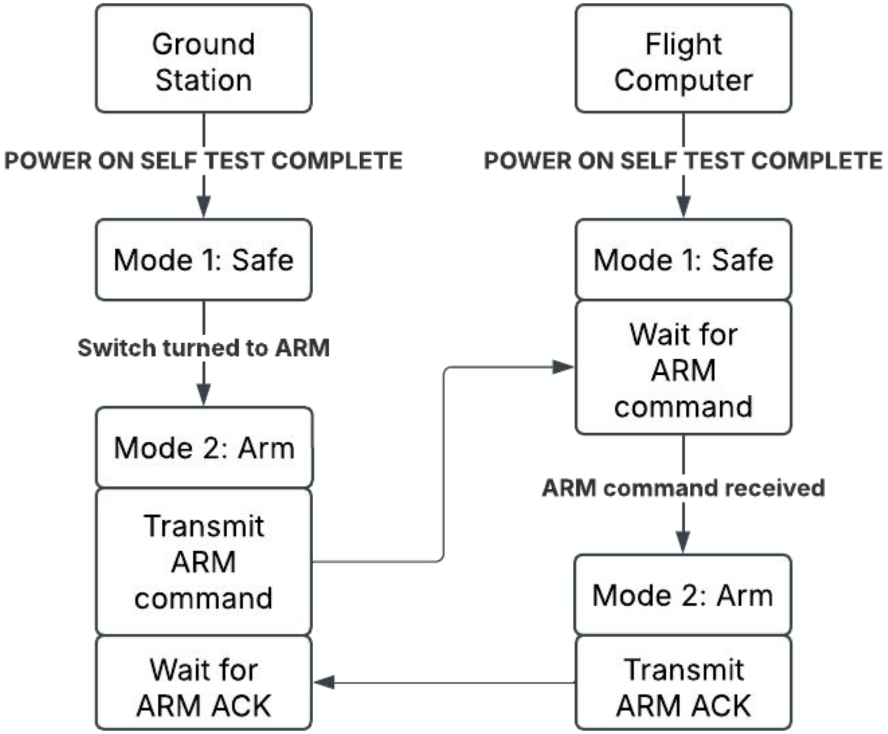
Methodology: Safety



- Rocket motors and igniters are **flammable** and **explosive**.
- **Critical** that systems are **fail safe**.
- Arming and launching required a **multi-step** and **human-centered** process, with **active verification**



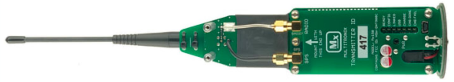
Subset of UML State Diagram

Test and Evaluation

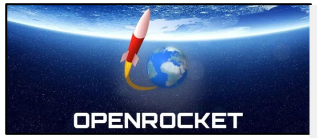
- **Build-up approach** including iterative hardware and software debug and integration for val/ver.
  - e.g. ignition interlocks, RF link
- Multiple **static and dynamic** ground and flight tests
  - e.g. commands, states, telemetry
- Comparison with existing COTS solutions for **size, weight, power, cost, performance**

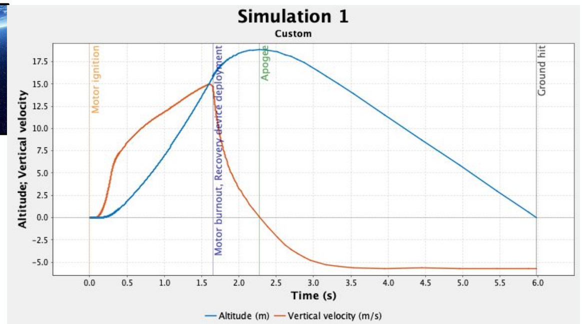
JollyLogic
AltimeterTwo

Multitronix
TelemetryPro

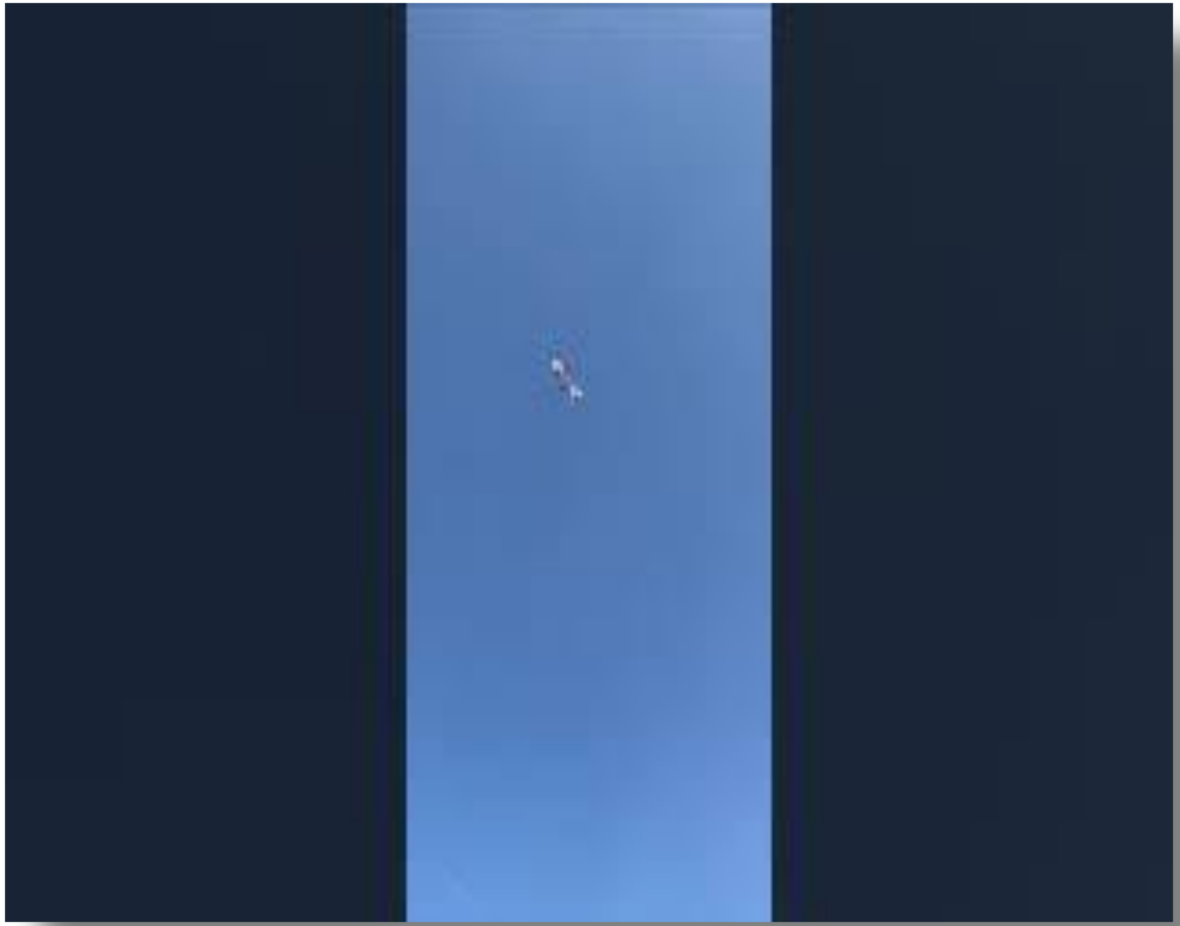


- "**Truth data**" from OpenRocket simulations, with ride-along data from a JollyLogic unit.





Video: *BOILER 7* mission launch (COREC Park, Purdue, 28 April 2025)



https://www.youtube.com/shorts/g5D2pSnxmoE

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Selected Results

Mission	Result	Details
Boiler 4	**Partial Success**	Apogee ~25 m. Data collection failure. Parachute deployment occurred too late. Action: Changed motor, improved code and data retention methods.
Boiler 7	**Success**	**Apogee** 16.1 m (flight computer) 22.6 m (Jolly Logic) 18.8 m (OpenRocket) **Peak velocity** 7.51 m/s (flight computer) 19.4 m/s (Jolly Logic) 16.5 m/s (OpenRocket)

Costs excluding rocket, motors, misc. parts:

- Our units: ~\$250 (\$125 each)
- JollyLogic: ~\$100
- Multitronix: ~\$3,000

Future Work

- RF reliability was a significant challenge. Opportunity for growth!
- Design system to require two separate human operators.
- Develop PCBs with IC components.
- Improve sensor calibration and simulation parameters.
- Utilize auxiliary storage for enhanced data logging and reliability.

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Questions?

Thank you for your attention!

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