ASCEND StratoDevils High Altitude Ballooning

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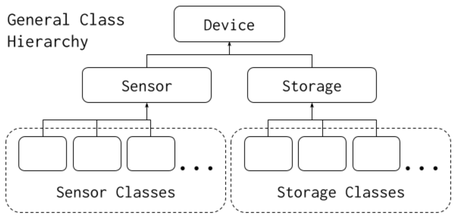
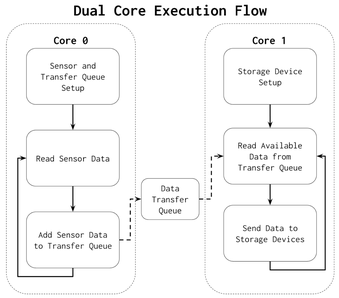
Software Subsystem



The flight software is designed to be **modular**, allowing it be modified easily between payload iterations. Peripherals are abstracted, inheriting from a parent class that allows each to be managed identically despite implementation differences.



Parallel Computing: Utilizing the RP2040's dual ARM Cortex-M0+ cores, the flight software splits tasks to be completed in **parallel** (see above).

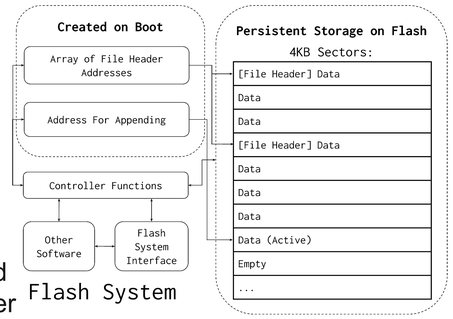
Packet System

Data is **stored** and **transmitted** directly encoded into packets, reducing the space needed for each data point and adding **validation** in the form of a checksum. Packets are **variable** in length, with each one's content defined in the Sensor Presence field of the Header.

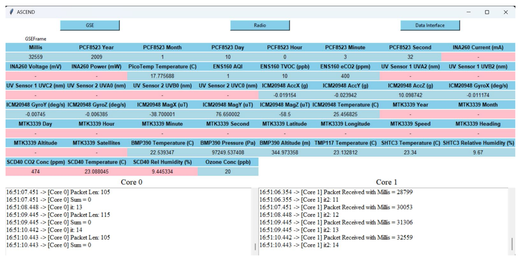
Header (10 Bytes)				
Sync Bytes	Sensor Presence	Packet Length (N)	Data	Checksum
4 Bytes	4 Bytes	2 Bytes	N - 11 Bytes	1 Byte

Spring Flight Data
Encoded: 2528KB (4.167B / data point)
Decoded: 7831KB (~3.1 times encoded)

Flash Storage System



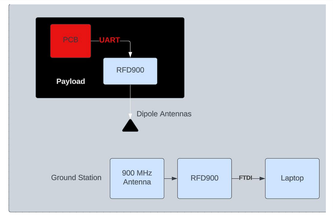
In flight, the system is **addition-only** with a new data grouping created each flight. Flights don't share sectors in memory and are divided by a header sequence, allowing existing files to be indexed quickly. The system can be interacted with via USB, allowing specific flights to be transferred as raw data to a connected computer.

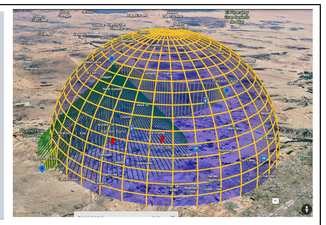


Ground Software

Streamlines the debugging process by **decoding** packets in real time and sorting serial output by the core it originates from. Reused for the telemetry ground station to decode packets received over radio.

Telemetry Subsystem





RFD900 Radio Module: Operates at 900 MHz with a range ~40 km, 1 Watt transmit power, and a 64 kbps data rate. This enables real-time data transmission from the payload to our chase vehicle throughout flight.

Payload Antennas: Two +3 dBi half-wave dipole antennas mounted to the payload ensure directional signal strength and redundancy.

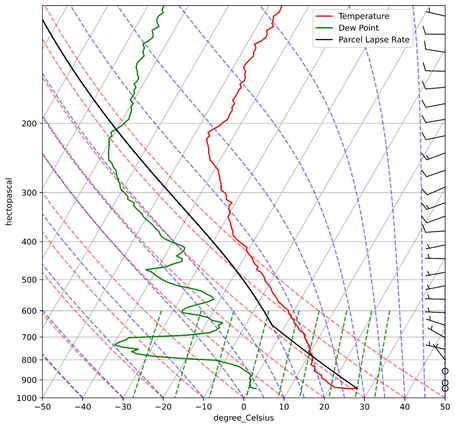
Mobile Ground Station: Equipped with a +6 dBi Yagi PCB antenna and a +2 dBi omnidirectional wheel PCB antenna, both mounted to the chase vehicle for signal acquisition during flight and descent.

Science Mission - Atmospheric Sounding

A Skew-T Log-P thermodynamic diagram visualizes pressure, temperature, humidity, wind speed and wind direction data. Plotted using MetPy and Matplotlib.

This vertical profile shows a thermodynamically stable sounding, with rising air cooler and denser than the environmental air.

The tropopause can be seen just above 250 hPa, with temperatures beginning to increase with temperature instead of decreasing, indicating the transition to the stratosphere.



Software Toolkit

Development: Platform.io and Tkinter

Collaboration: GitHub and Jira

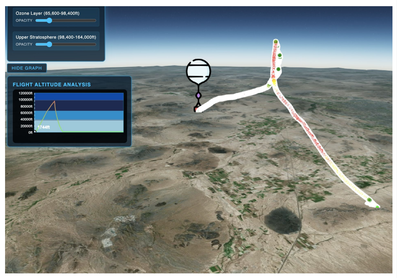
Documentation: Doxygen and Clang-format

3D Visualization

Actual flight path visualized from GPS data.using the Cesium.js Javascript platform.

High accuracy and **real-time animation** on a background of the actual earth powered by Google Earth

3D atmospheric layering to distinguish sections of the flight



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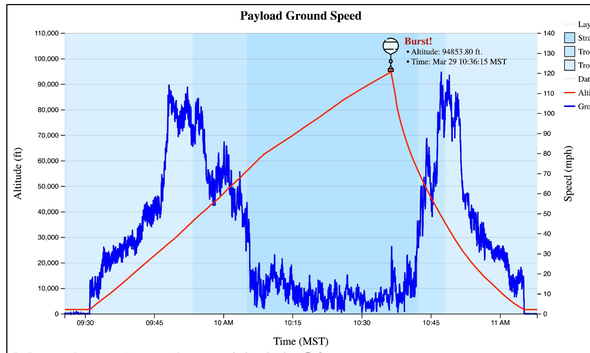
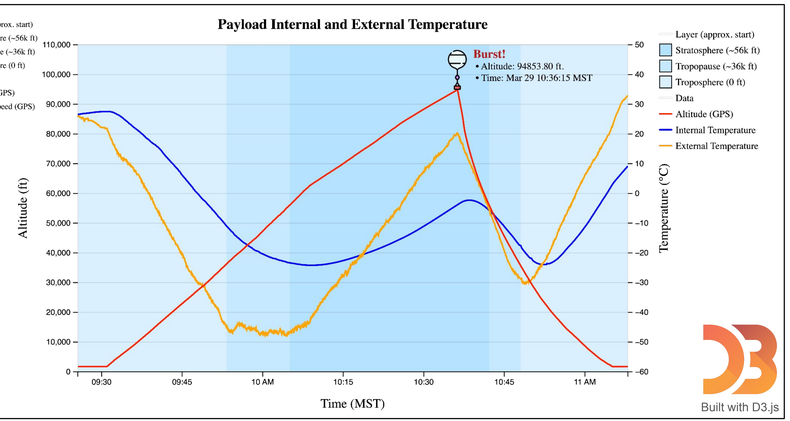


Max Acceleration: 13.31 G's

Max Ground Speed: 120.89 mph



Project Repository:

Check out our PCB design, flight data, and source code for the flight software, ground station, and analysis.

Acknowledgments

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