

Open-Source CubeSat Technology: Developing the Obi Wan Computer and Combined Payload Board

Background

- Oakwood's NyanSat was selected by the NASA CubeSat Launch Initiative (CSLI) Call 15¹; NyanSat is slated for launch in 2026.
- Based on PyCubed², we designed these boards to allow for easier integration into larger and more complex satellites.
- We also targeted easier manufacturing and sourcing; mostly single-sided with readily available components.
- The Combined Payload Board (CPB) is designed to act as a versatile payload interface, suitable for many mission designs.

OBC Design Process

Derived from PyCubed

- Developed stacking connector protocol for board interoperability
- Transitioned memory component from to large MRAM & PSRAM
- Converted from 4-layer to 6-layer PCB
 - Removed routing from top/bottom component layers
 - 2 designated signal layers
 - Alternating with designated power & ground planes (two ground regions, six power regions).
- Added more solar charging and simplified burn-wire circuitry
- Added high-reliability connectors for power, deployment switches
- Moved towards using bipolar and P-FET circuit for power gating to maximize radiation tolerance

Change of microcontroller

- Removed the ATSAMD51 microcontroller due to vulnerability to upsets from solar radiation³; converted to the RP2350B.

Watch Dog and Supervisor Circuit

- Novel circuit that cycles power upon request, power anomaly, or failure of microcontroller to toggle a signal at correct rate.

CPB Design

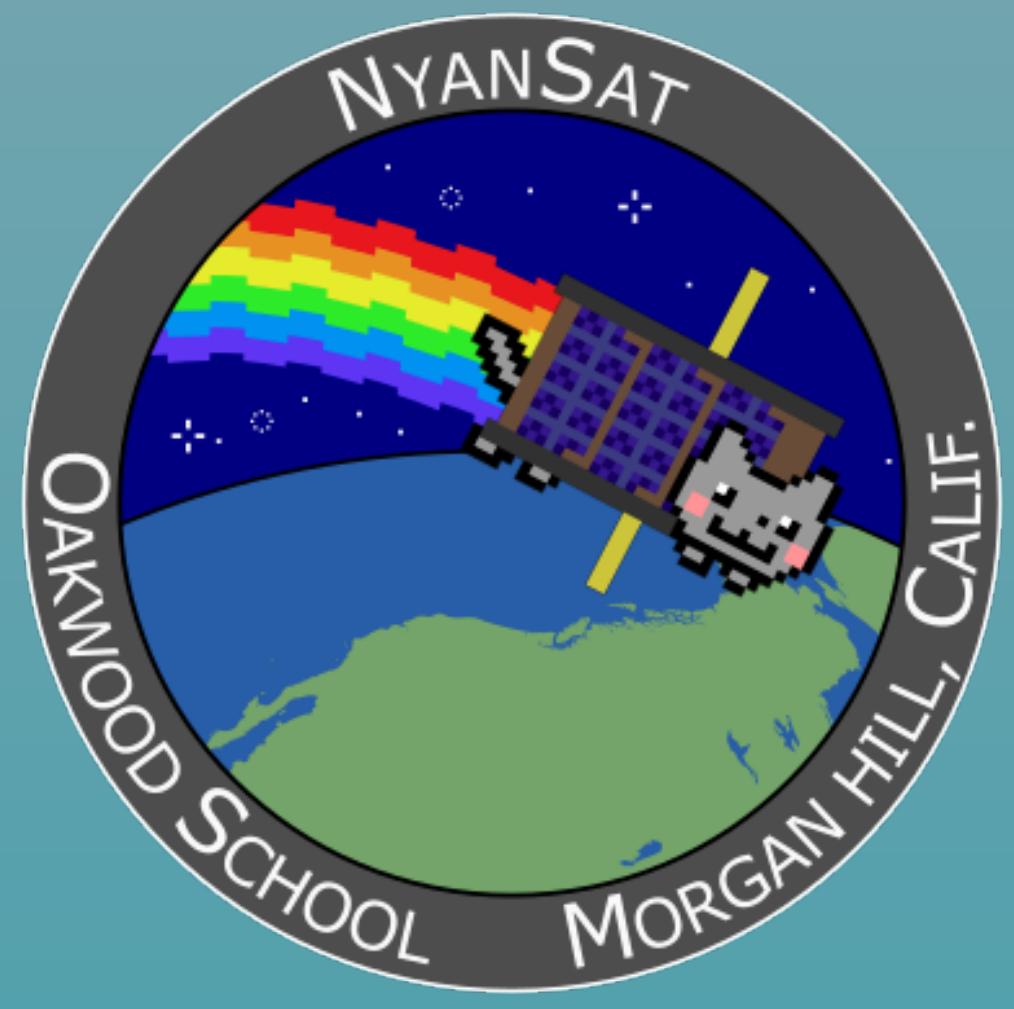
- Initial thoughts about separate cards for each payload
 - Decided we wanted to consolidate most payload functions onto a single versatile board
 - Many IO and power switches that can be used for various purposes
- Off by default
 - 5 gated power domains
 - Power gated by pins on stacking connector; subdomains gated by I2C peripherals
- Enabled and commanded by OBC
 - Designed to remain safe and maintain partial functionality even if program memories are corrupted.

Technical Specifications

Both Boards:

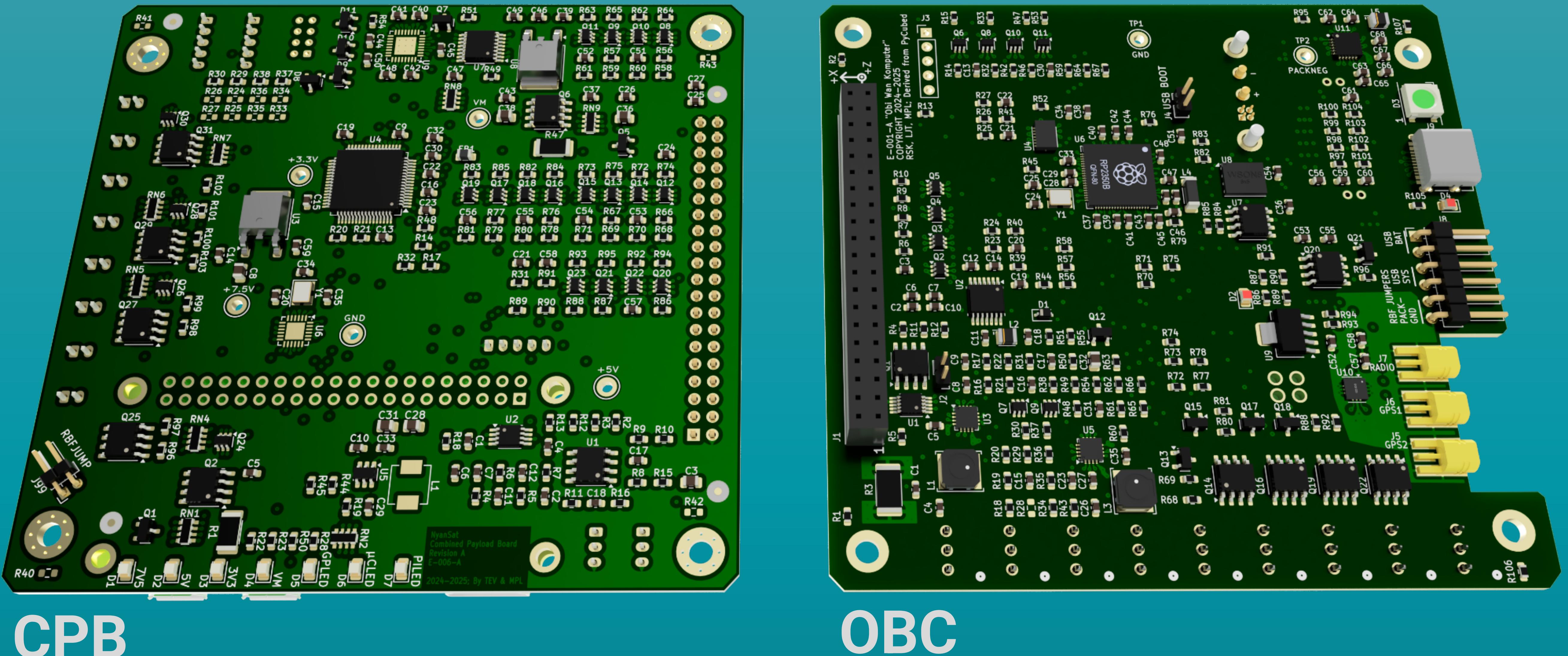
- 6 layer PCB board with 2 power layers and 2 signal layers
- No traces on top or bottom with vias in pad
- Stacking Connector (in PC/104 location, with our own pinout)

OBC



Versatile Flight Computer and Payload Board for CubeSats

Derived from PyCubed



CPB

OBC

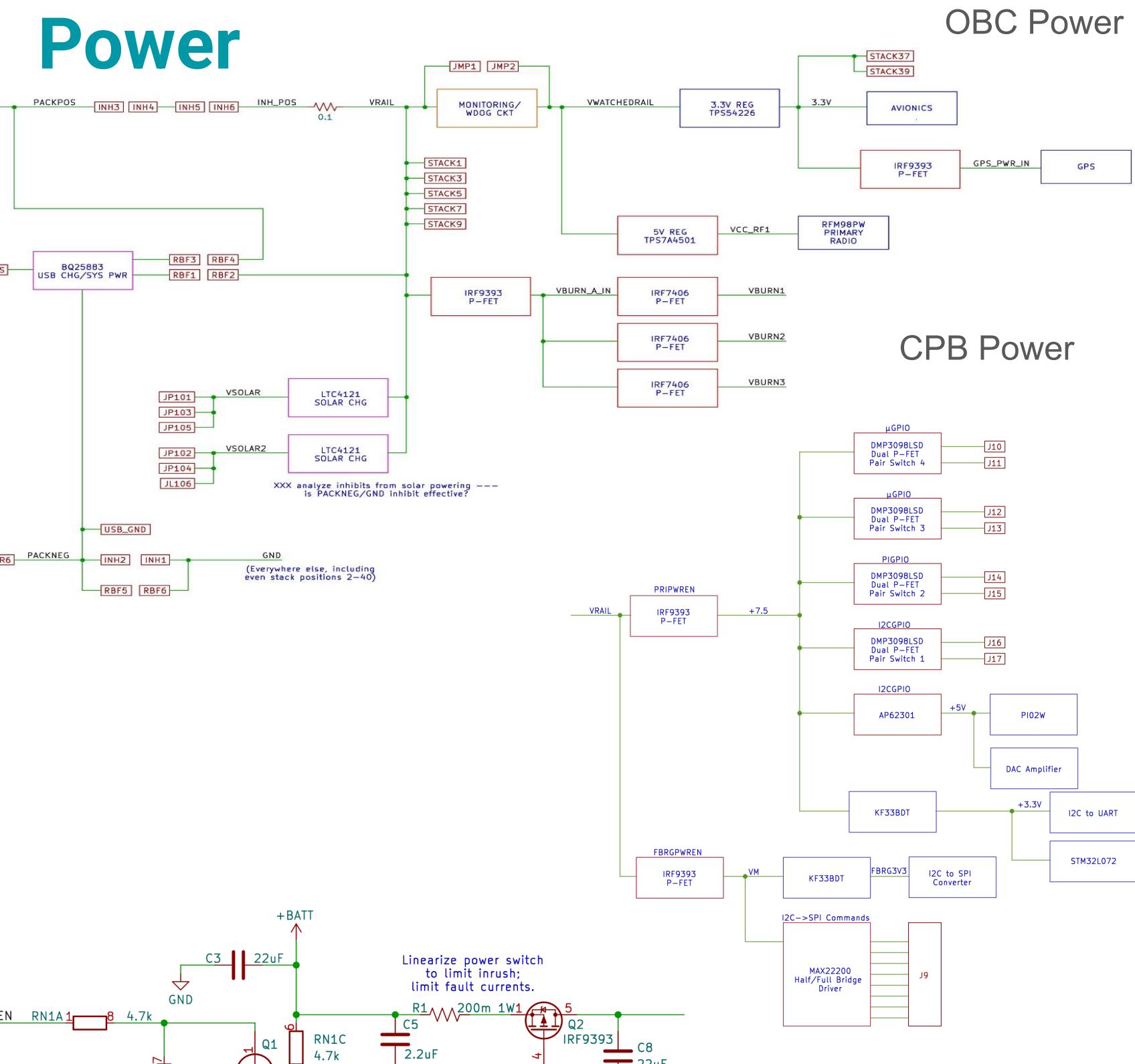
Open Source

Applications & Next Steps

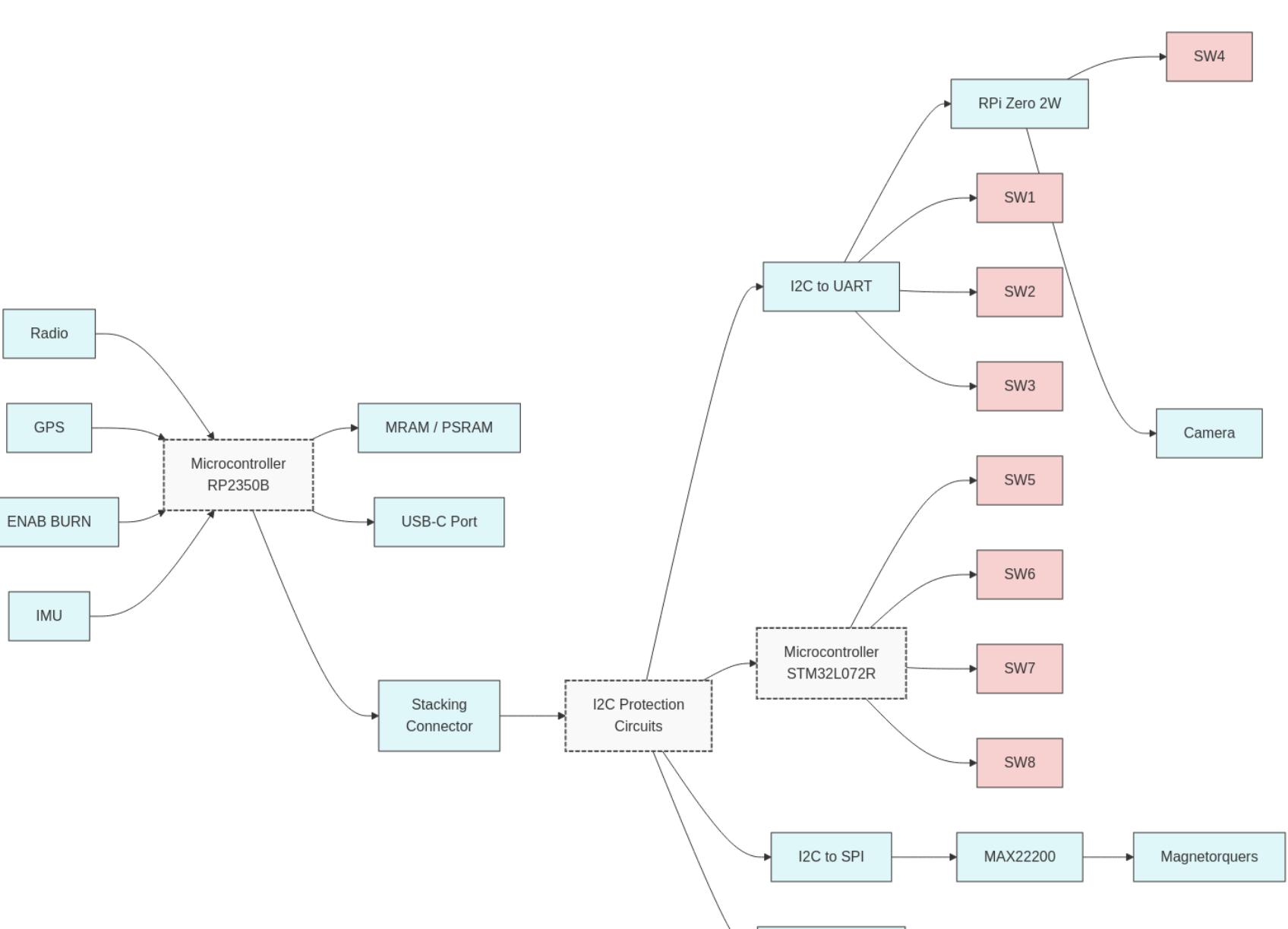
- As two primary circuit boards for the NyanSat mission, they will manage everything from communication to power and control systems for the CubeSat.
- All hardware is open sourced; flight software will be open-sourced, providing a foundation for the broader CubeSat community to build upon.
- OBC Rev AF bringup in progress and looking good after successful OBC Rev 1
- CPB Rev A bringup successful with no significant errata.
- We intend to continue building open avionics and increasing our capabilities.

Easily fabbed and assembled by commodity manufacturing

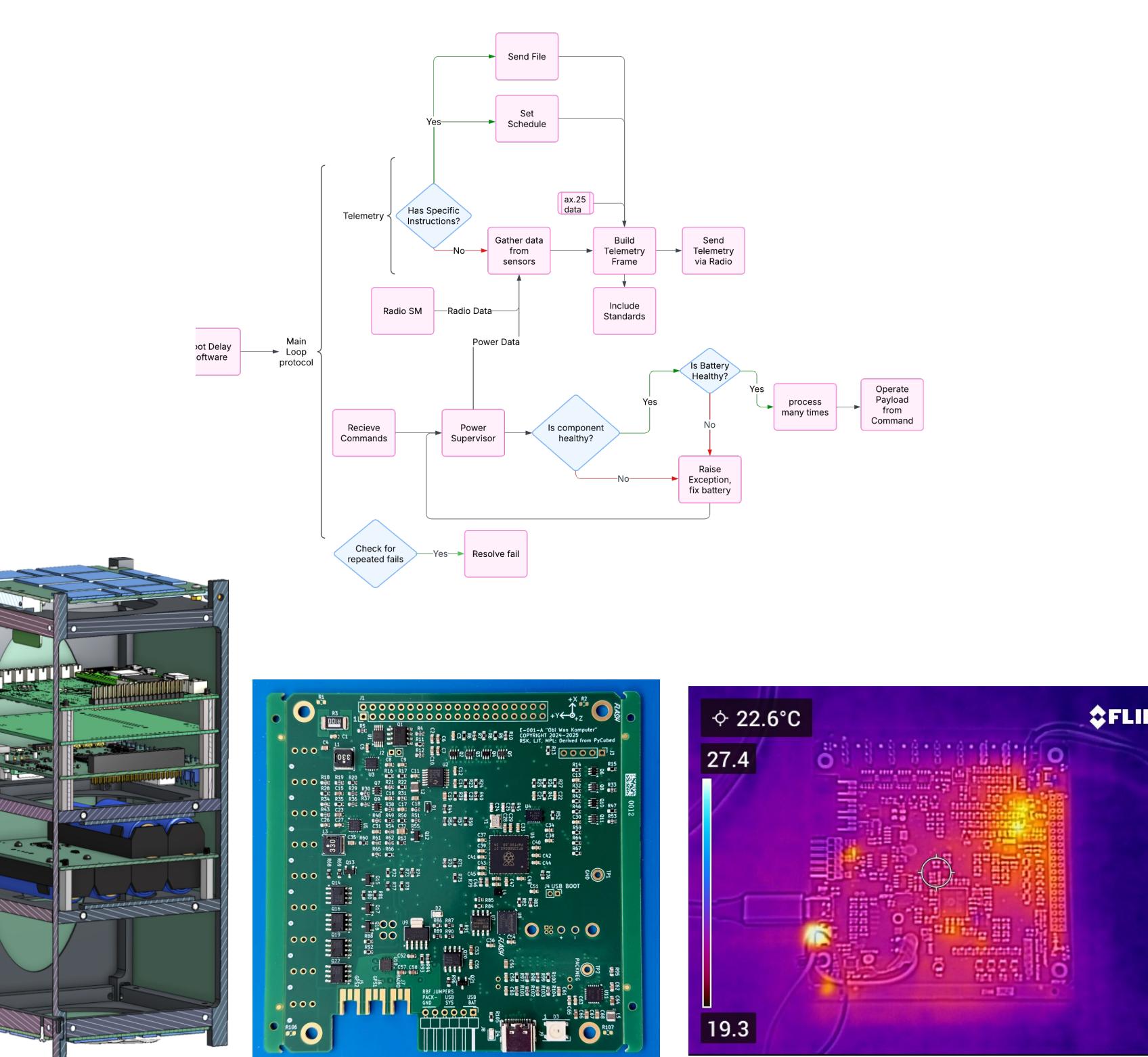
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HARDWARE



SOFTWARE



Citations

- NASA Selects New Round of Candidates for CubeSat Missions. National Aeronautics and Space Administration, Washington D.C., USA <https://www.nasa.gov/centers-and-facilities/kennedy/nasa-selects-new-round-of-candidates-for-cubesat-missions-to-space/>
- Maximilian Holliday, et al. PyCubed: An Open-Source, Radiation-Tested SmallSat Framework Programmable Entirely in Python. <https://pycubed.org/>
- PyCubed: NOTICE - AUGUST 1 2024 <https://github.com/pycubed/forums/discussions/87>
- Maximilian Holliday, Gabriel Buckmaster, Zachary Manchester, et al. On-Orbit Implementation of Discrete Isolation Schemes for Improved Reliability of Serial Communication Buses. TechRxiv. August 13, 2021. <https://techrxiv.org/doi/full/10.36227/techrxiv.1516620.v1>

