CornellEngineering
Electrical and Computer Engineering

DeSCENT ChipSat Ground Station

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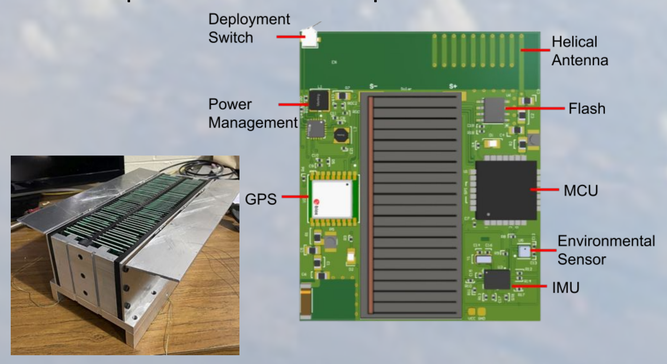
DeSCENT Mission: What is a ChipSat?

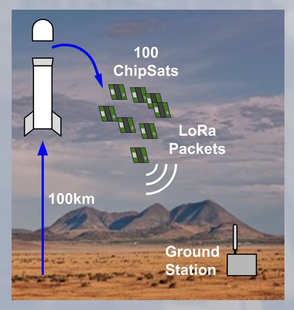
A gram scale satellite on a chip
- "R selected", many small spacecraft instead of a single large one

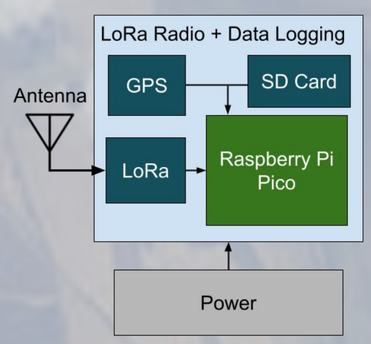
DeSCENT Mission Goal: Deploy a swarm of 100 Chipsats in a 90 min suborbital launch. Collect + transmit sensor data and retrieve as many as possible.
- Can ChipSats survive atmospheric descent?



Motivation for a Ground Station:
How well can we hear our ChipSats?
What data did they collect?
Where should we look to find them?

Ground Station Requirements





- LoRa communication:
- Log + store received packets
- Maintain power for duration of mission
- Scalability + minimal setup required

Hardware Design

Adafruit MicroSD Breakout: easy data storage + retrieval, SPI

RFM95 LoRa Module: previously used for ChipSats, SPI

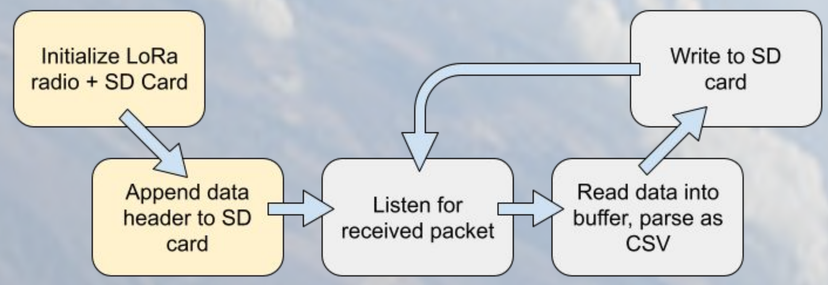
Microcontroller: Raspberry Pi Pico, extra support + resources from Hunter Adams

Todo - GPS Module: can get location + real time

Software Design

Pico SDK: more complicated than Arduino, but more options

Radiolib library for LoRa, previously used for ChipSats



Estimating Total Power

Setup + mission duration + retrieval: 6-12hrs

No GPS: consumes ~50mA at 3.3V
- Without GPS power consumption is mostly constant

+GPS (from datasheet): 20mA at 3.3V, updating every second
- Can be lowered, depending on ChipSat packet freq

Total Power: 230mW for 12 hrs, or ~2800Wh
- Spec battery for 1000mAh at 3.7V (eg. LiPo)

Other considerations: voltage regulator, battery management

Packet Format

Option 1: Total size 61B							
ChipID	GPS	Gyro	Accel	Mag	Temp	Hum	Press
1B	4Bx3	4Bx3	4Bx3	4Bx3	4B	4B	4B
Option 2: 37B							
ChipID	GPS	Gyro	Accel	Mag	Temp	Hum	Press
1B	4Bx3	2Bx3	2Bx3	2Bx3	2B	2B	2B

100 ChipSats transmitting every 20 sec

→ At most 2GB (Assuming we hear every ChipSat on a single GS, unlikely)

Future Exploration

Antenna Selection:
- Suborbital launch means a shorter transmit distance
- Radiation pattern? Point towards sky but not in any specific direction. We don't know where ChipSats will be
- Easy to set up

Remote Data Access:
- Can monitor received data during mission
- SD card as a failsafe
- Eg. over LoRaWan? Cellular?

Pointing Antenna:
- Secondary high gain antenna to track specific ChipSats
- Motorized design to aim antenna

Acknowledgements

I would like to thank my advisor Dr. Hunter Adams, Mark Lohatepanont, and the rest of the DeSCENT ChipSat Team for their guidance and support on this project.

Goddard, C., & Gromes, J. (2024, January). RadioLib Non-Arduino Raspberry Pi Pico Library Example. GitHub. https://github.com/jgromes/RadioLib/blob/master/examples/NonArduino/Pico

Gromes, J. (n.d.). RadioLib. RadioLib documentation. https://jgromes.github.io/RadioLib