

Background & Objective

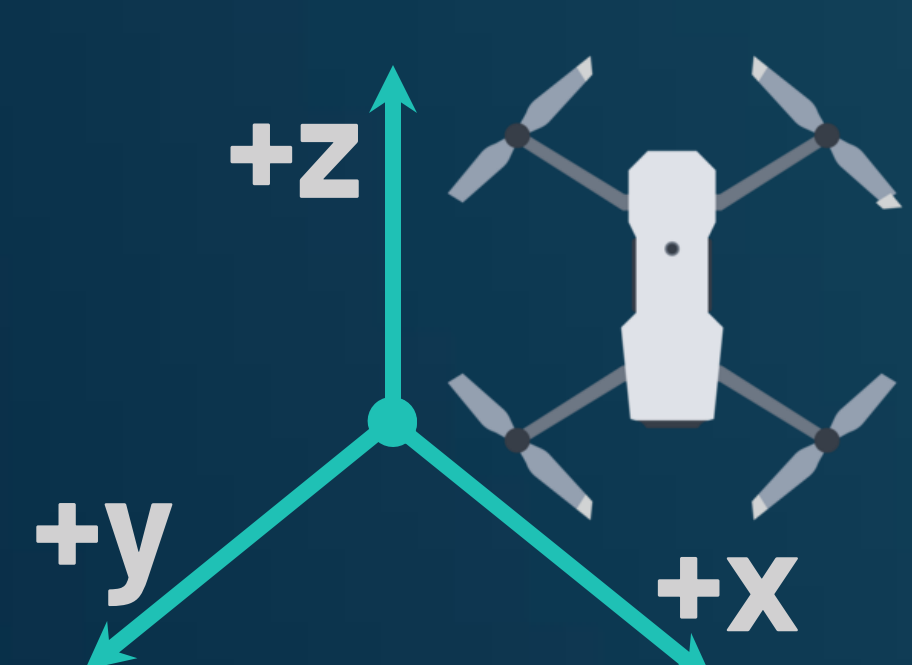
- Goal:** Use a drone to demonstrate an affordable way to simulate satellite configurations to improve the reliability of satellite missions
- Validate Rendezvous and Proxy Operations (RPO) by performing Design Reference Missions (DRMs) as validation

Key Requirements

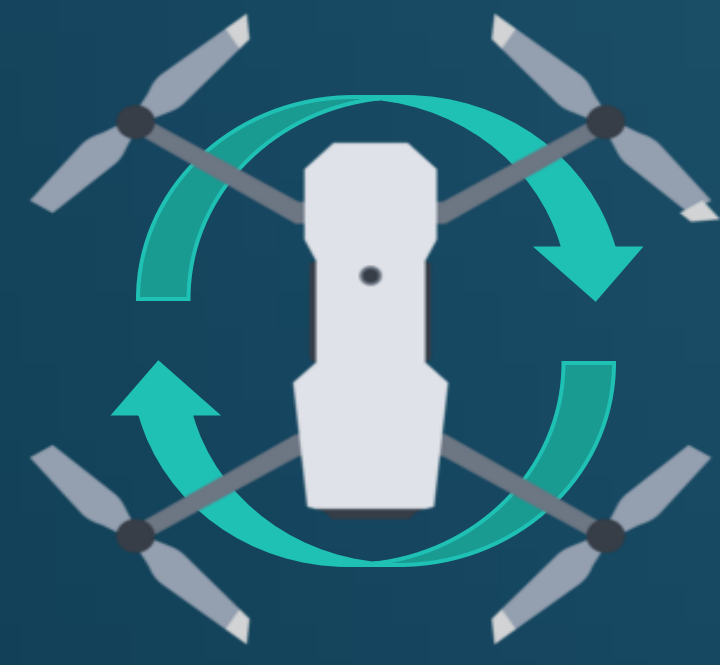
- 15-minute flight time
- Have an absolute location system
- Precision & Accuracy within ± 1 inch
- Have "Safety" & "Emergency Stop" switch
- Accept thruster commands in matrix form to maintain constant velocity & acceleration
- Autonomous flight with minimal pilot inputs

Missions

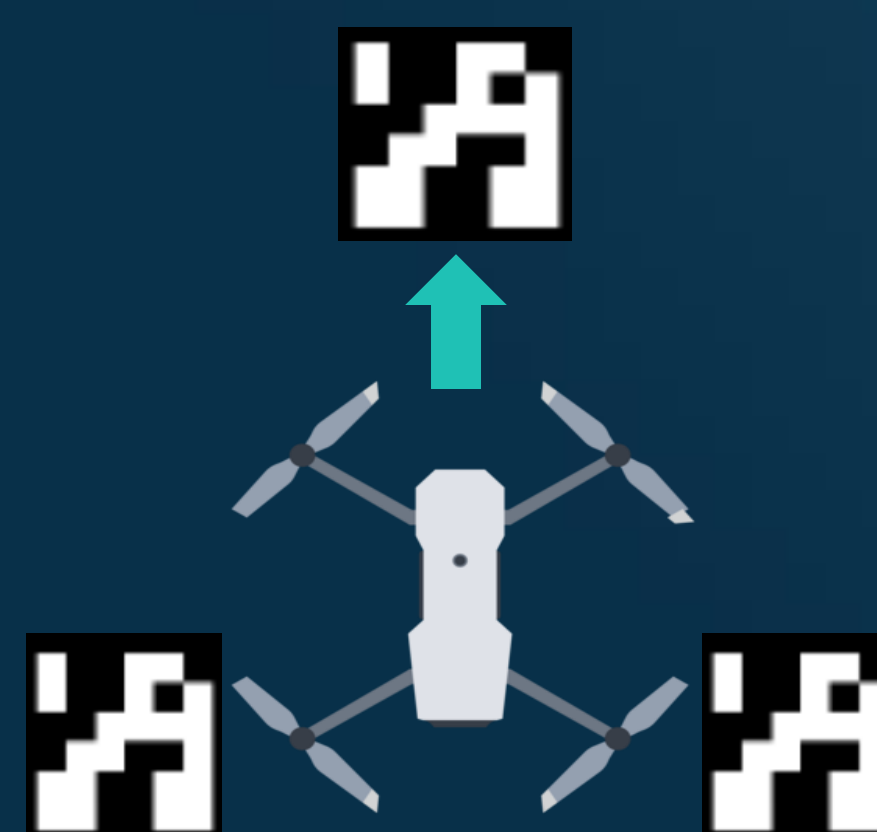
- Design Reference Missions provided by Sierra Space
- Testing milestones
- Showcases drone's dynamic abilities



0: Hover
1, 2, & 3: X, Y, Z Movement



4: Rotation about Z

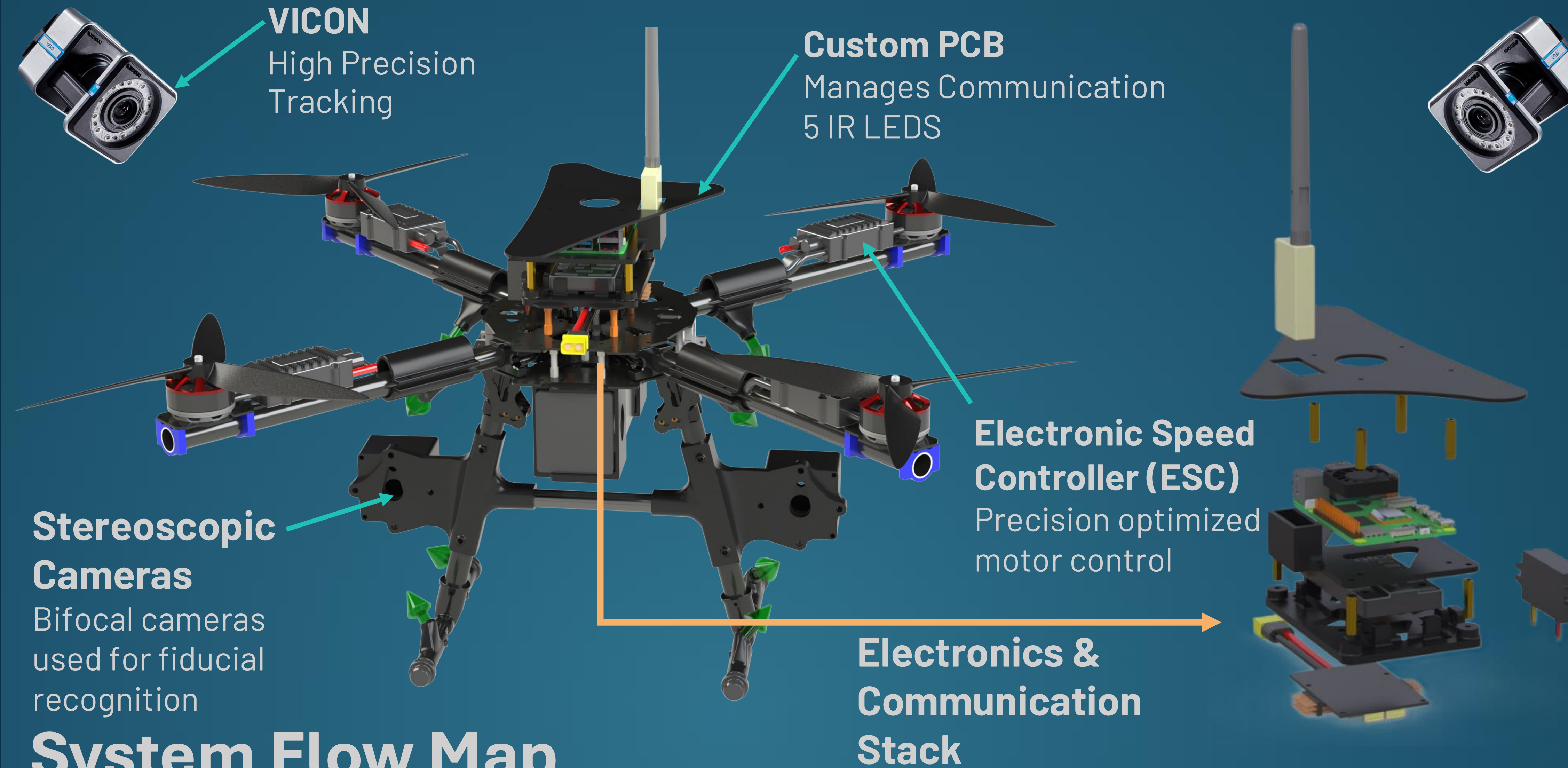


5: Approach
6: Survival



7: Orbital Mechanics

Design



System Flow Map

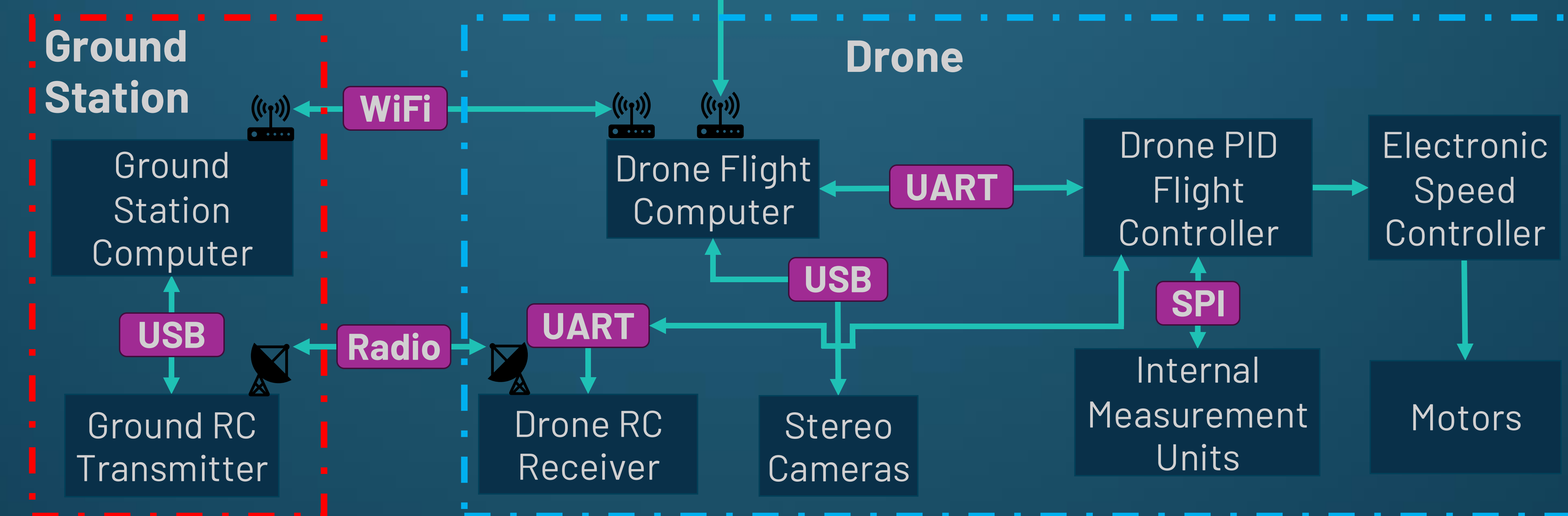
Electrical Facts:

- 4 independent IMUs
- Dual 216 MHz Processor flight controller
- 18.5-minute flight time

VICON Positioning System

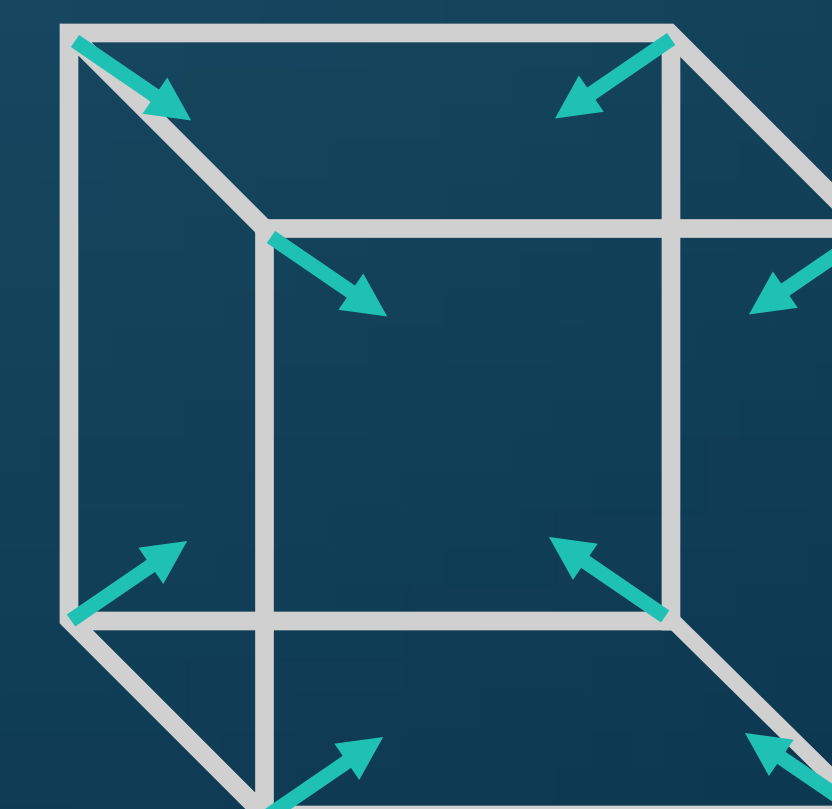
Software Facts:

- 4,000+ lines of code
- 19 different scripts
- 4 different communication protocols
- <100 ms response time



Satellite Representation

- 8 thrusters, all pointed inward
- Thrusters indicate constant acceleration
- Commands given through matrix form
- Desired movement based on corresponding thruster activation



Testing & Results

Facility:

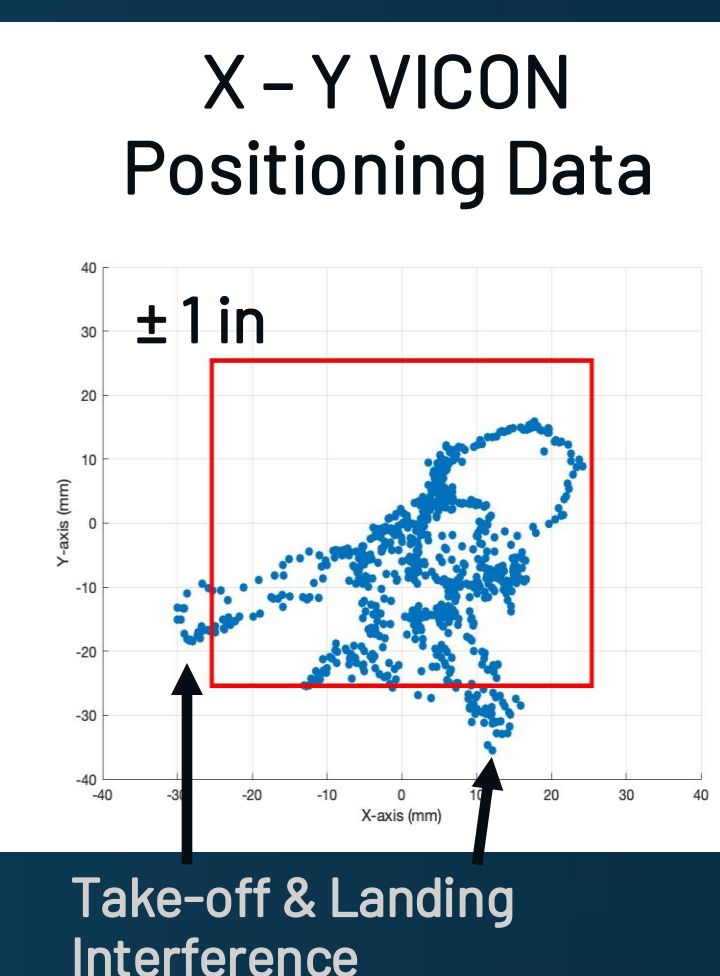
- Autonomous Systems Programming Evaluation and Networking Lab (ASPEN)

VICON:

- Camera array that simulates GPS indoors
- Accuracy within $\pm 1.5 - 2.0$ mm
- Communicates via Wi-Fi to RPi 5 flight computer

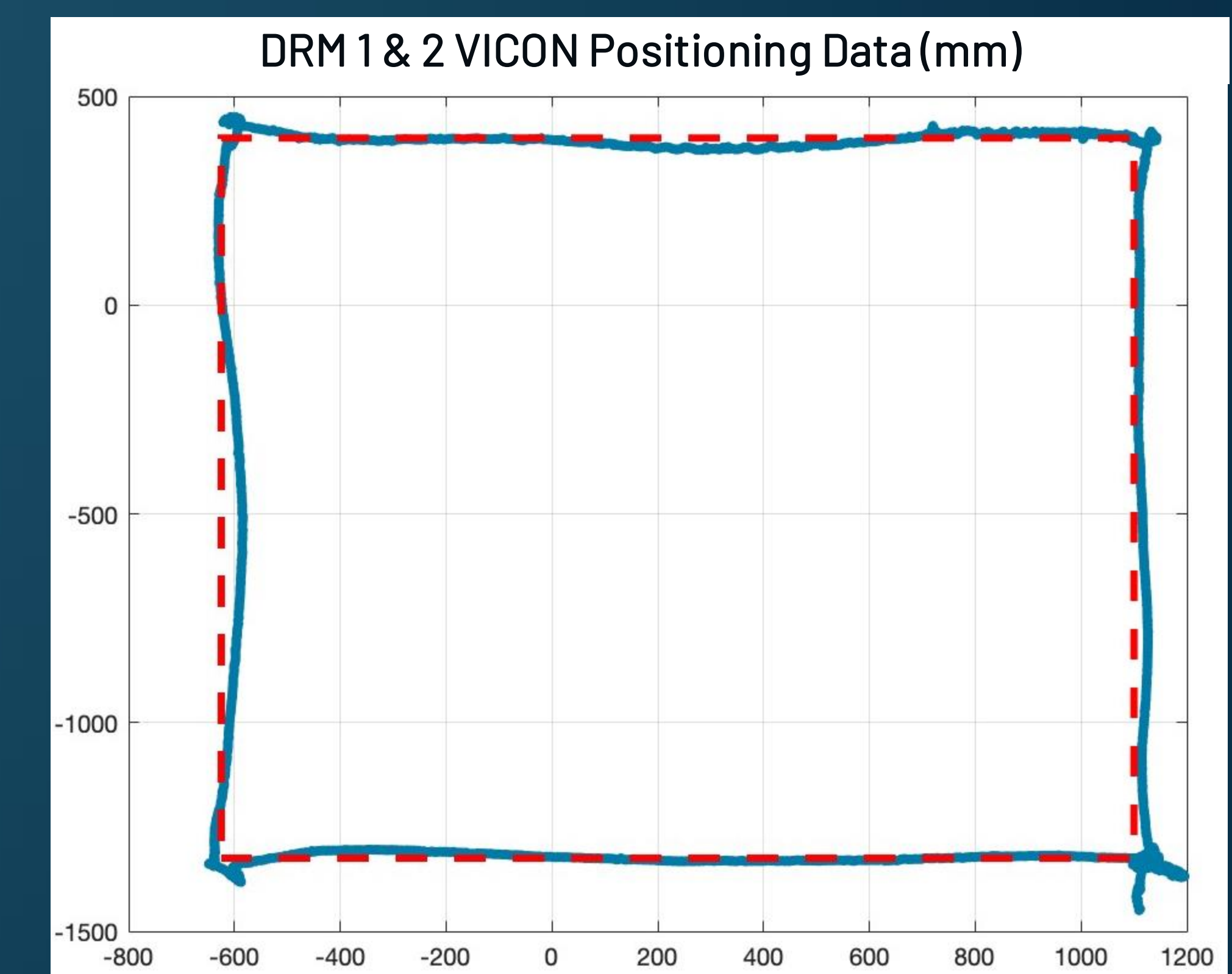
Testing DRM 0:

- Mission 0: X-Y Positioning
- 5-minute flight
- 98.1 % within X bounds
- 97.3 % within Y bounds
- VICON position data to 1:1 scale



Testing DRM 1 & 2:

- Controlled movement in X and Y
- Minor drift of ± 1 inch
- Error in initial take off and landing



Challenges

- Part selection through trade studies
- Risk management during testing
- Software debugging
- Setting up communication between VICON and Pixhawk
- Software/Hardware collaboration