TEAM SEVEN
TEST READINESS REVIEW

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TEAM SEVEN
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PROJECT OVERVIEW

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Project Purpose

- Develop a navigation system to improve the energy efficiency of an unmanned aerial system
- Deploy system to extend lifespan of fixed wing drone, serving as communications relay for first responders in remote locations

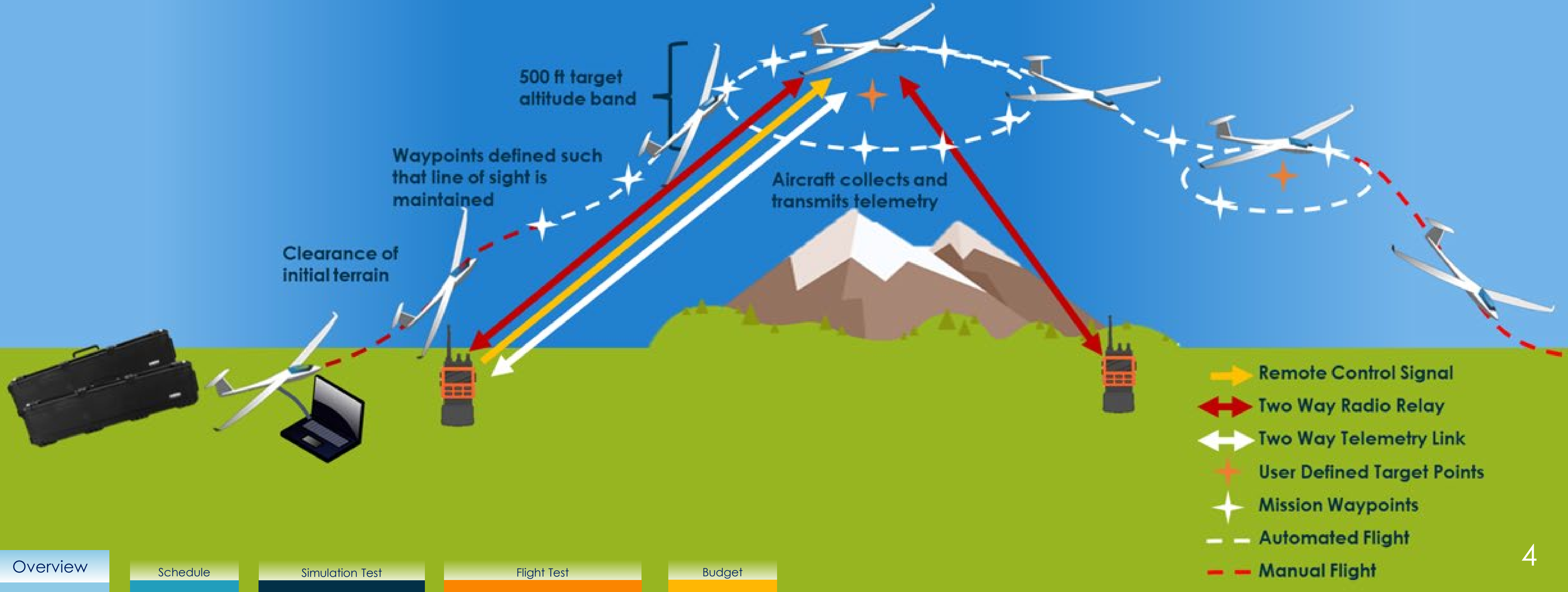
Specific Objectives

- Develop navigation software to optimize flight trajectory to increase vehicle endurance
- Utilize in-situ wind measurements to dynamically update flight plans
- 20% improvement of endurance from baseline flight will prove the systems' efficacy

Testing Location: CU Boulder South

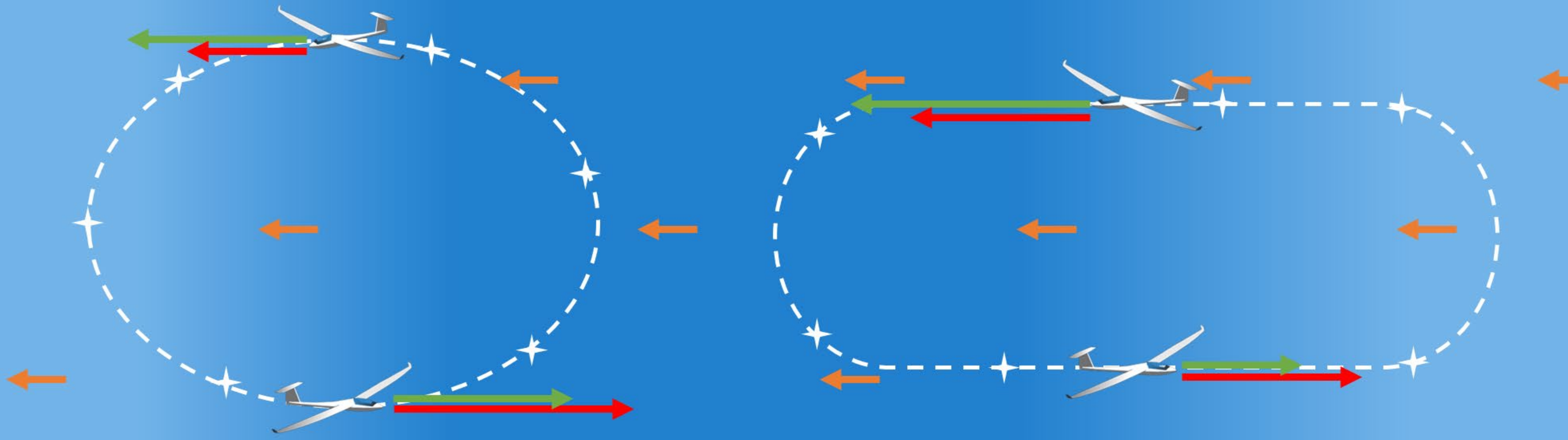
TEAM SEVEN Concept of Operations

1: Transport	2: Prep	3: Launch	4: Climb	5: Loiter	6: Descent	7: Holding	8: Landing
Modular setup allows from rapid deployment	Ground system defines initial waypoints	UAS takes off under manual control.	UAS ascends and transits to target location.	Station held over target area	Return to designated loiter area and altitude	Holding loiter allows user to retake manual control	Manual control for final descent and touchdown



Optimization Concept of Operations

Initial Circular Orbit | **Optimized Orbit**



Flown at constant groundspeed while taking initial wind data

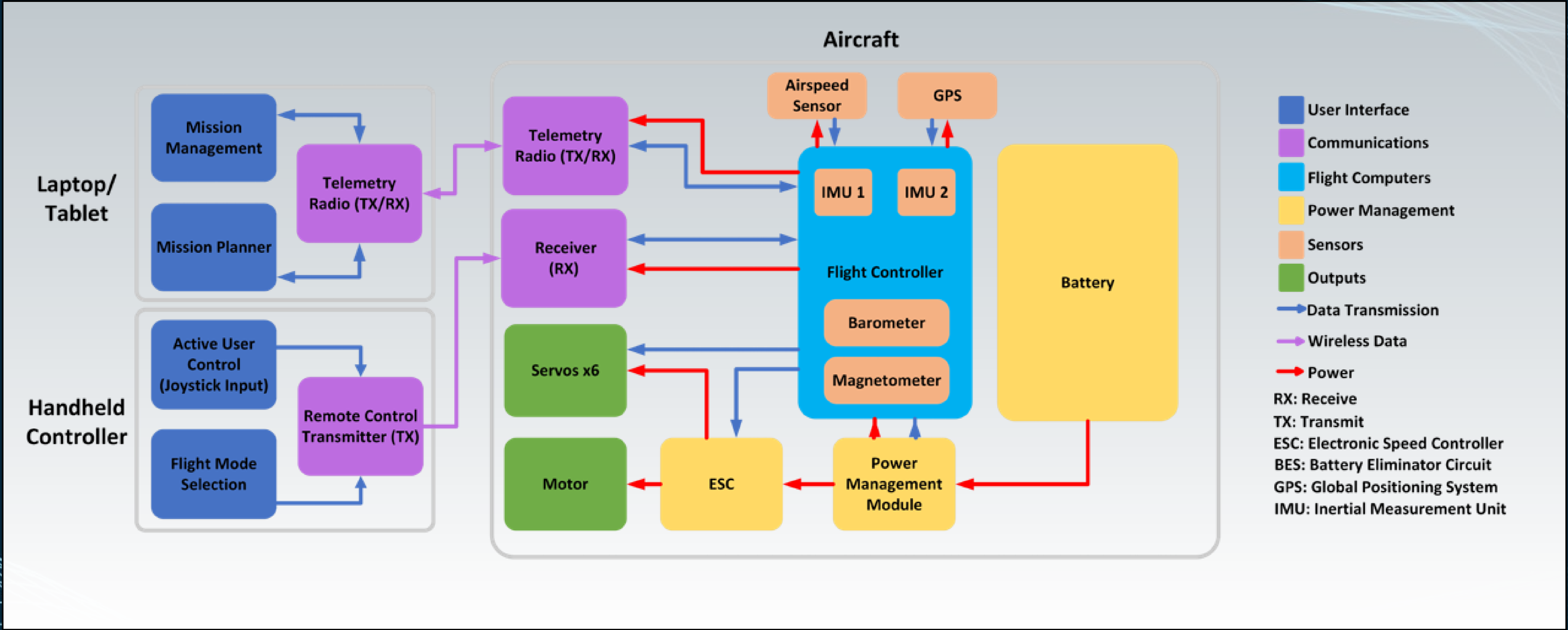
Updated orbit profile uploaded from ground station.

Constant airspeed near Pr_min with crab angle minimized

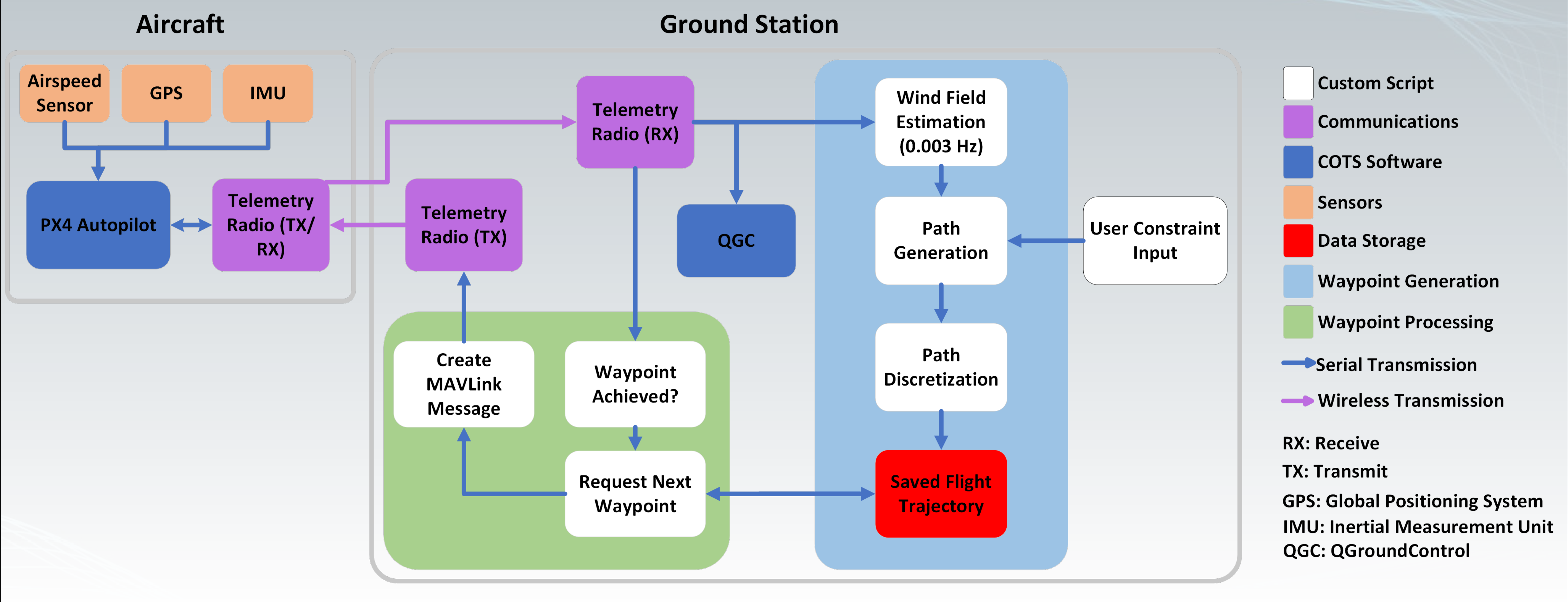
Mission Waypoints
Airspeed
Groundspeed
Wind

*Waypoints consist of position and commanded groundspeed

HARDWARE FBD



SOFTWARE FBD



MAJOR DESIGN CHANGES

CDR Design	TRR Changes	Reasoning/Impact
Augment the native PX4 controls with our own control laws	Removed team working on PX4 flight controls in favor of navigation software	• Minimal improvement to energy efficiency • Opens schedule to focus on navigation software
On-board computer to send setpoints to Pixhawk flight controller	Using MAVLink messages to communicate with PX4 via radio transmission	• Save battery power on UAS by not powering companion computer
Using ROS2 to communicate with PX4	Using MATLAB/Python scripts to send MAVLink messages to PX4	• Familiarity with MATLAB/Python over ROS2 • Shortens learning time required to write communication software

CRITICAL PROJECT ELEMENTS

Energy Management

- Primary focus of the project
- Increased endurance will prove project success
- Considered in all steps of project from flight trajectory to battery usage

FR 2	FR 3	FR 6

Wind Measurements

- Technically challenging
- Optimized flight trajectory is dependent upon accurate wind measurements
- Critical to project success

FR 1	FR 3	FR 5

Flight Boundaries

- Necessary safety consideration
- Preserves line-of-sight
- Obstacle avoidance

FR 1	FR 4	FR 5

*Functional Requirements in Additional Slides

PROJECT SCHEDULE

TEST EVENTS

Component Testing	
Motor Characterization	2/13
Communication Range Testing	2/28
Attitude Sensor Verification	2/22
GPS Position Verification	2/22
Inertial Velocity Verification	2/22
Body Rotation Verification	2/22
Airspeed Sensor Verification	2/24
Route Creation Software Demo	3/6
Wind Estimation Software Demo	3/20

Bench Tests	
System Bench Test 1: Basic RC Functions	2/24
System Bench Test 2: Flight Controller Integration	2/27
Power Baseline	3/6

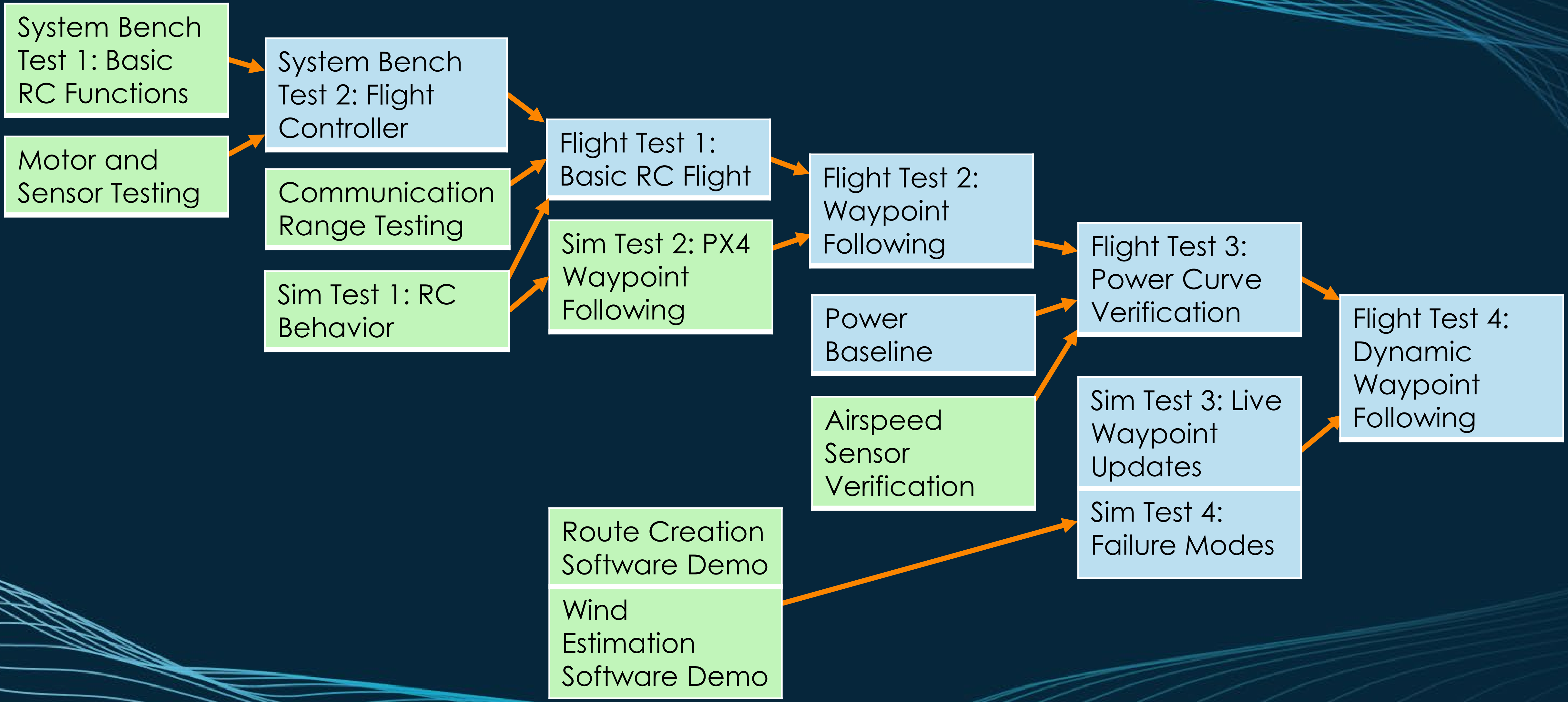
Simulation Tests	
Sim Test 1: Remote Control Behavior	2/13
Sim Test 2: PX4 Waypoint Following	2/22
Sim Test 3: Live Waypoint Updates	3/10
Sim Test 4: Failure Mode Analysis	3/17

Flight Tests	
Flight Test 1: Basic RC Flight	3/17
Flight Test 2: Waypoint Following	4/5
Flight Test 3: Power Curve Verification	4/12
Flight Test 4: Dynamic Waypoint Following	4/19

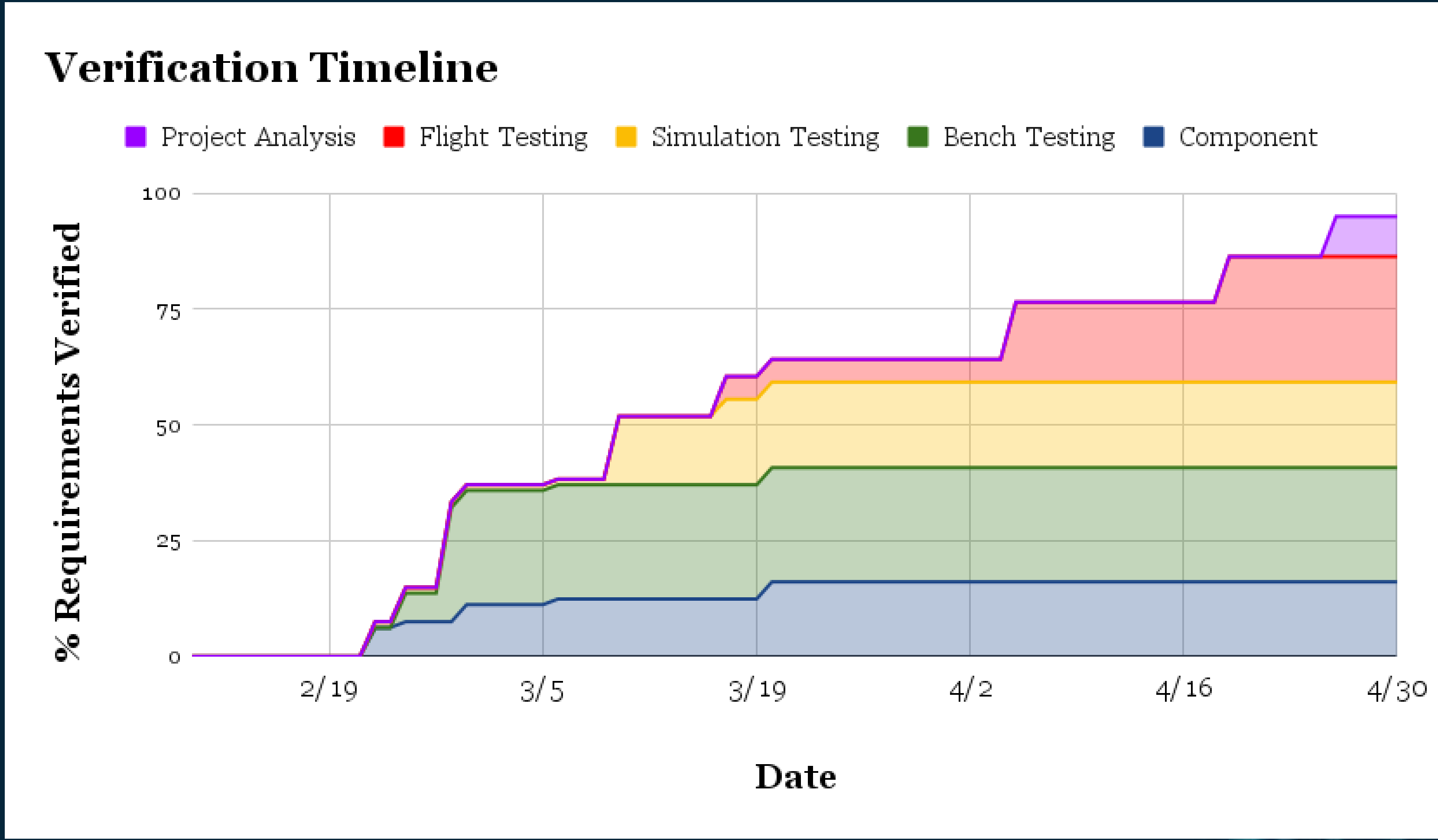
Completed

Presenting On Today

TEST DEPENDENCIES



VERIFICATION PLAN



Simulation Testing

Sim Test 1 - RC Control

Sim Test 2 - Waypoint Following

Sim Test 3 - Live Waypoint Updates

Sim Test 4 - Failure Modes/Safety Fe...

Flight Testing

Project Analysis

Flight Test 1 - Basic RC Flight

Flight Test 2 - Waypoint Following

Flight Test 3 - Power Curve Test

Flight Test 4 - Dynamic Waypoint Fo...

Software Development

Navigation/Topology Software Integra

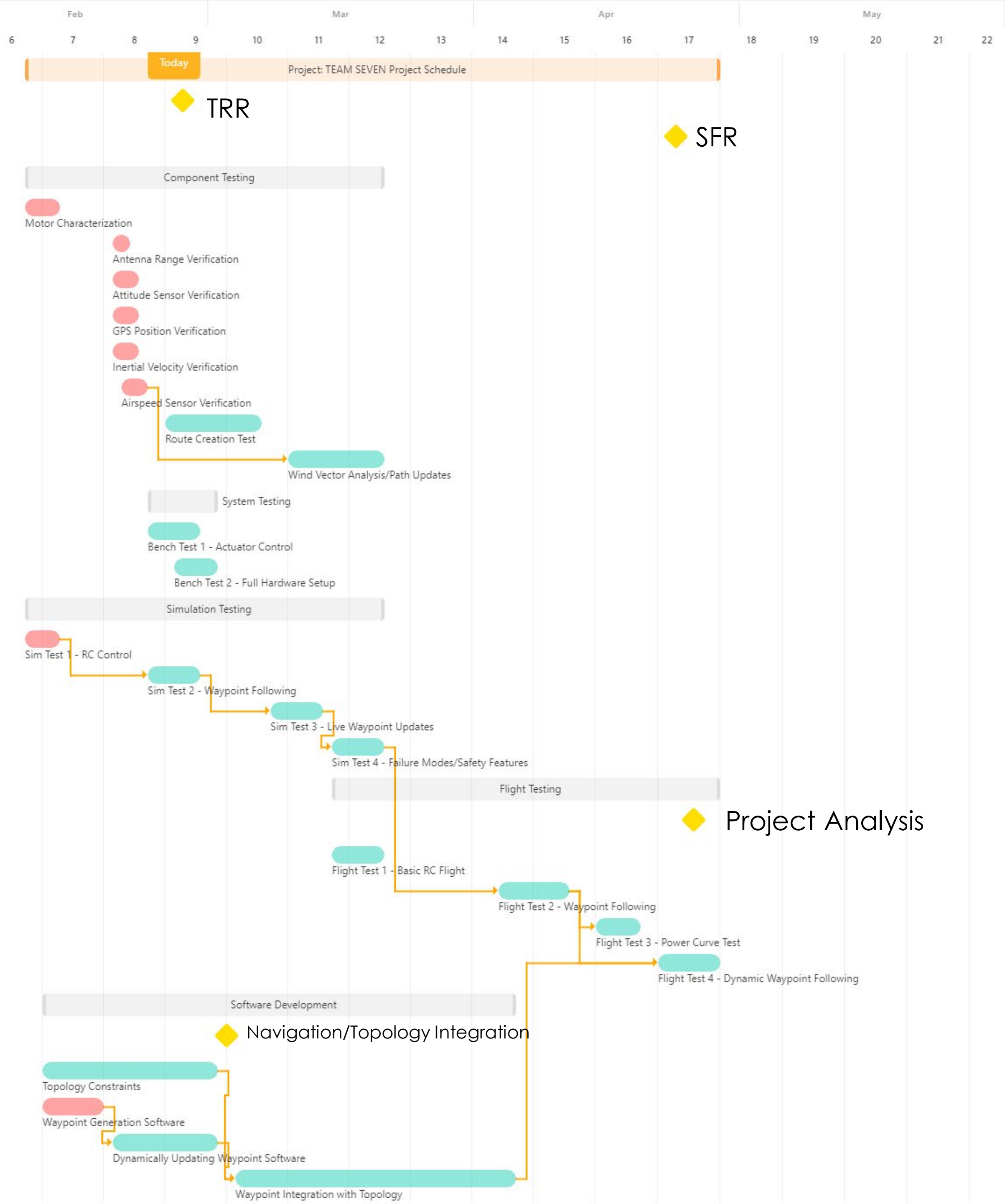
Topology Constraints

Waypoint Generation Software

Dynamically Updating Waypoint Sof...

Waypoint Integration with Topology

TASK NAME	TASK DATES
Project: TEAM SEVEN Project Schedule	**Feb 10 – Apr 29**
Test Readiness Review	Feb 27
Spring Final Review	Apr 24
Component Testing	**Feb 10 – Mar 22**
Motor Characterization	Feb 10 – Feb 13
Antenna Range Verification	Feb 20 – Feb 21
Attitude Sensor Verification	Feb 20 – Feb 22
GPS Position Verification	Feb 20 – Feb 22
Inertial Velocity Verification	Feb 20 – Feb 22
Airspeed Sensor Verification	Feb 21 – Feb 23
Route Creation Test	Feb 26 – Mar 8
Wind Vector Analysis/Path Updates	Mar 12 – Mar 22
System Testing	**Feb 24 – Mar 3**
Bench Test 1 - Actuator Control	Feb 24 – Mar 1
Bench Test 2 - Full Hardware Setup	Feb 27 – Mar 3
Simulation Testing	**Feb 10 – Mar 22**
Sim Test 1 - RC Control	Feb 10 – Feb 13
Sim Test 2 - Waypoint Following	Feb 24 – Mar 1
Sim Test 3 - Live Waypoint Updates	Mar 10 – Mar 15
Sim Test 4 - Failure Modes/Safety Fe...	Mar 17 – Mar 22
Flight Testing	**Mar 17 – Apr 29**
Project Analysis	Apr 26
Flight Test 1 - Basic RC Flight	Mar 17 – Mar 22
Flight Test 2 - Waypoint Following	Apr 5 – Apr 12
Flight Test 3 - Power Curve Test	Apr 16 – Apr 20
Flight Test 4 - Dynamic Waypoint Fo...	Apr 23 – Apr 29
Software Development	**Feb 12 – Apr 6**
Navigation/Topology Software Integra...	Mar 4
Topology Constraints	Feb 12 – Mar 3
Waypoint Generation Software	Feb 12 – Feb 18
Dynamically Updating Waypoint Sof...	Feb 20 – Mar 3
Waypoint Integration with Topology	Mar 6 – Apr 6



ct Analysis

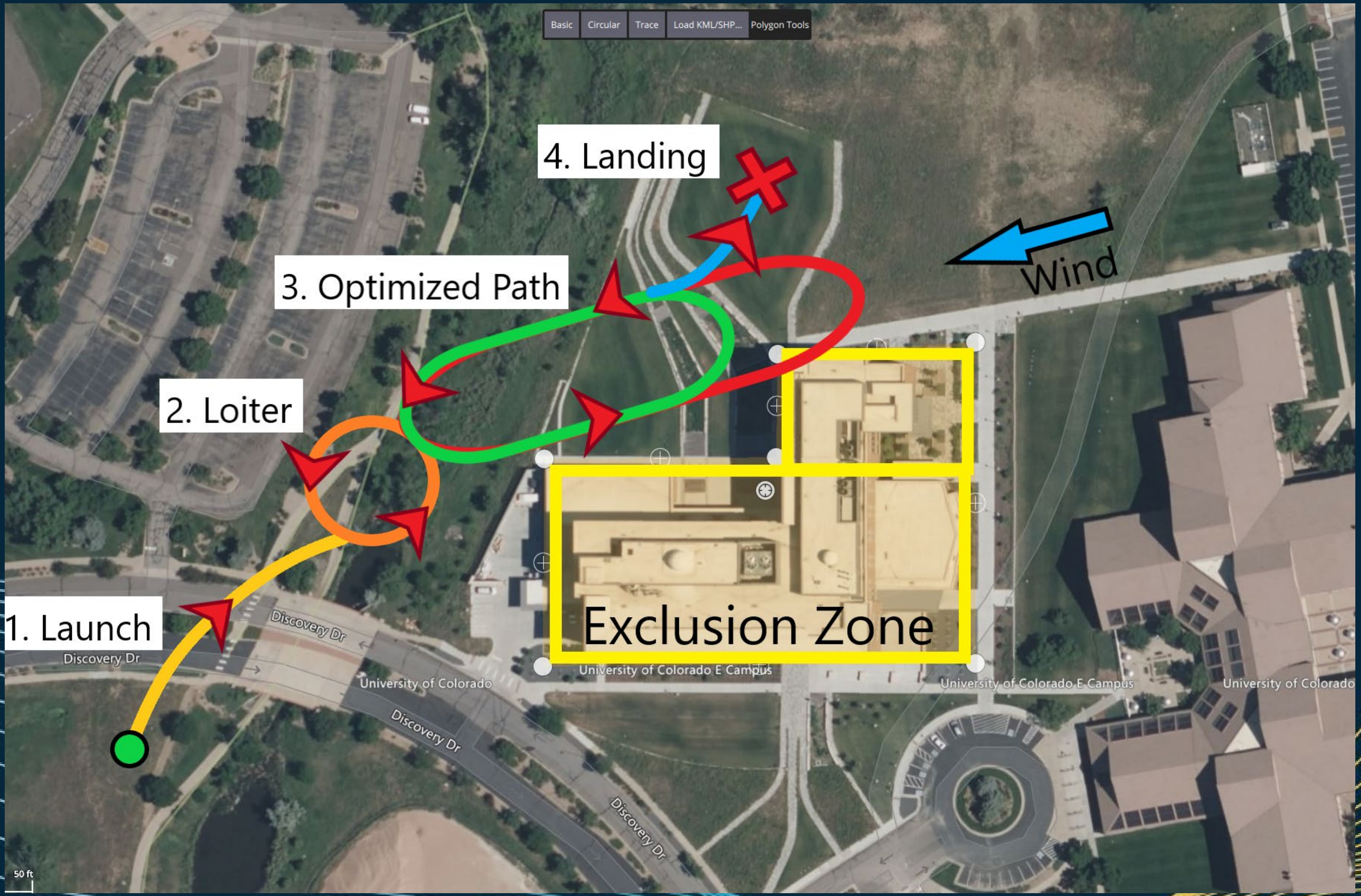
point Following

SIMULATION TEST – WAYPOINT UPDATES

TEST OVERVIEW

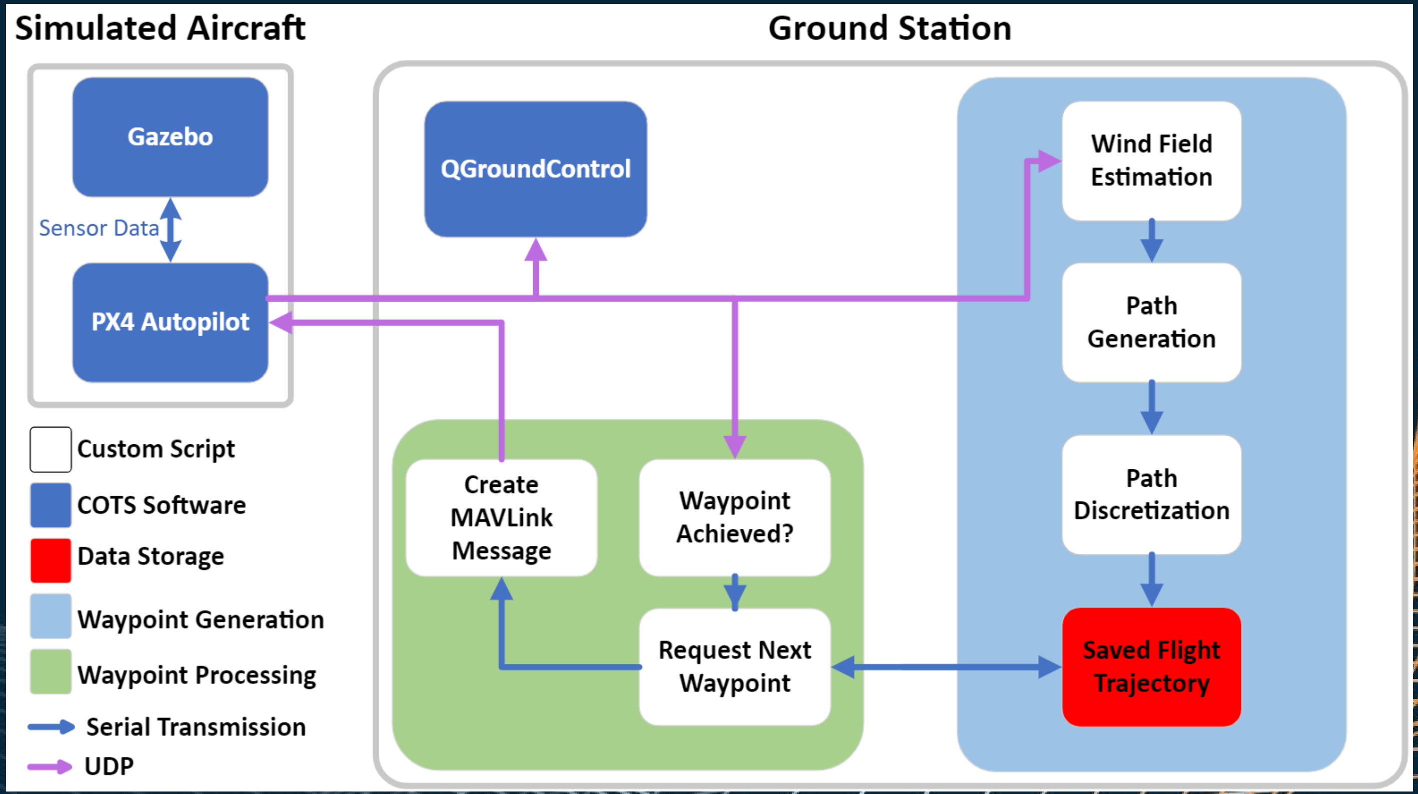
Main Goals

1. **Generate** and send waypoint plans to UAS
2. **Gather** and **verify** flight data and telemetry
3. **Verify** that waypoint plans avoid exclusion zones
4. **Verify** that waypoint plans can be generated with given sensor data



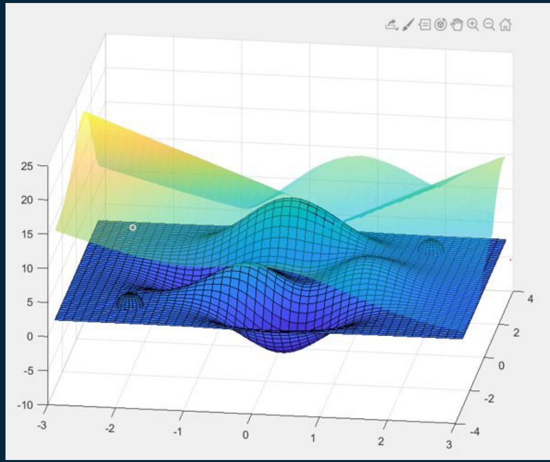
RISK BUYDOWN

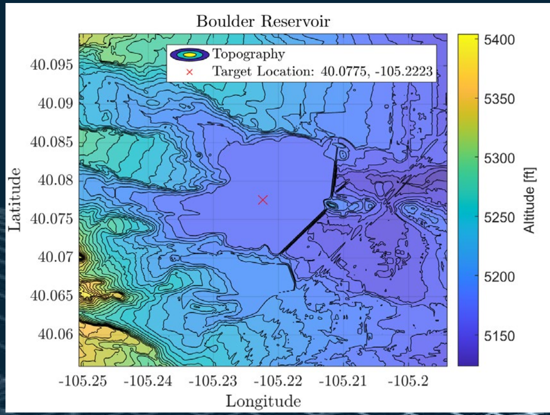
- Flight software failure
  - Reduces risk of failure in flight during future flight tests
- Mission Management Safety
  - Directly evaluates that mission management can create trajectories that avoid user-defined obstacles
- Software Integration
  - Verifies communication between mission management, QGroundControl, and PX4 autopilot.

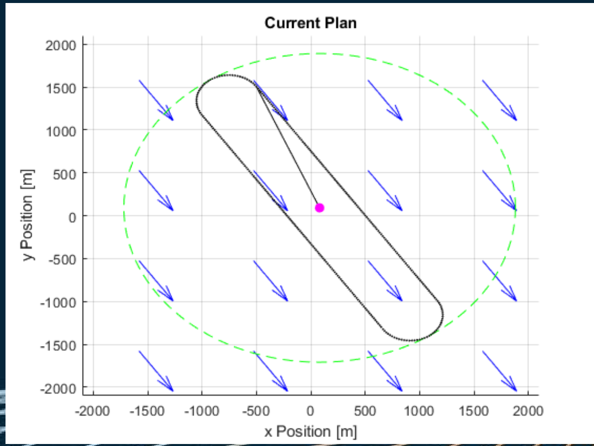


CRITICAL PREREQUISITES

- Simulation Test 2: Waypoint Following
  - PX4 autopilot is capable of following waypoints defined before flight.
  - Testing environment can accurately simulate PX4 waypoint following.
- Mission Management- Path Creation
  - Mission Management Software can create path with consistent LOS.
  - Paths respect exclusion zones.





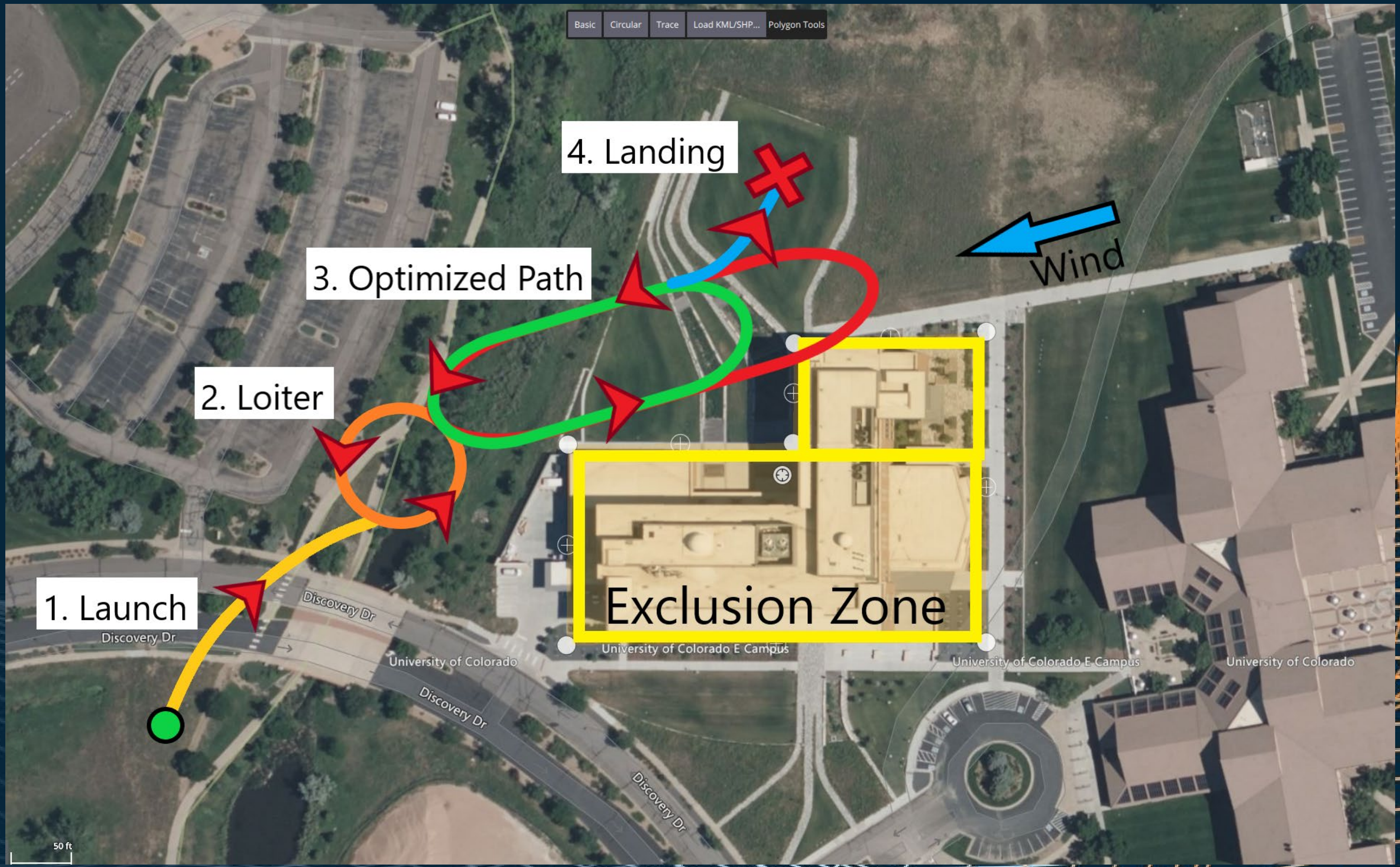


REQUIREMENT EVALUATION

	Expected Results	Requirements Validated
Path Generation Requirements	Avoids local terrain obstacles by **50 meters** and exclusion zones by **25 meters**.	2.2.2, 2.2.3
	Orbit waypoints are separated by at most **150 meters**.	2.2.7
Communication Requirements	New plan generation at least every **5 minutes**	2.3.2
	UAS executes waypoint path in **offboard mode**	1.4.2
Mission Execution	Navigates to within **20 meters** of waypoints	5.3.1
	Autonomous Flight	Mission Objective
	Flight Boundaries	Mission Objective

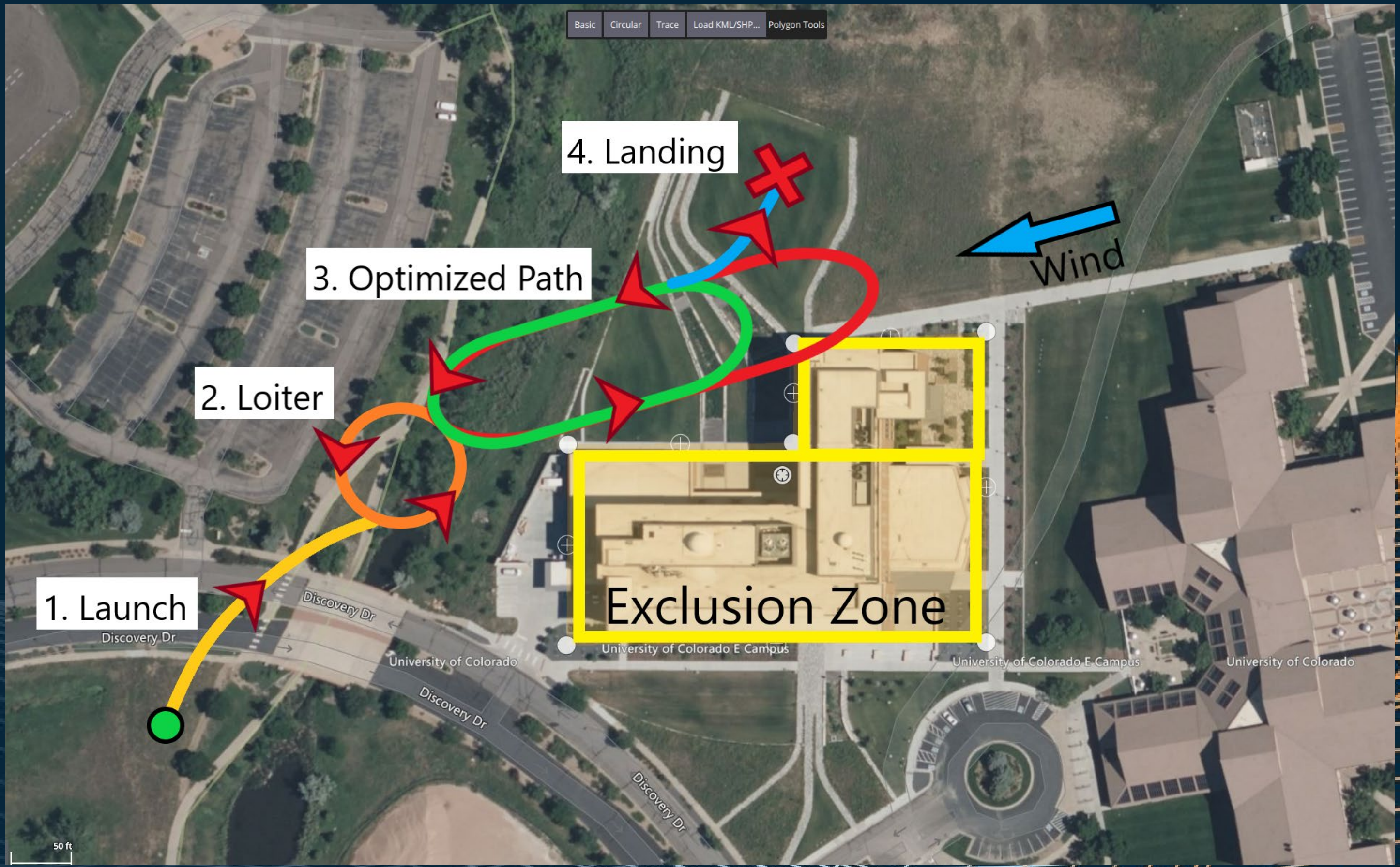
PATH GENERATION REQUIREMENTS

- Obstacles and Exclusion Zone
  - Waypoint plans within 50 meters of obstacles and 25 meters of Exclusion Zones are not sent
  - Verified with simulated telemetry [x,y,z] data
- Waypoint Separation
  - Euclidian distance between sequential waypoints < 150 meters
  - Verified with distance calculation between all generated sequential waypoints



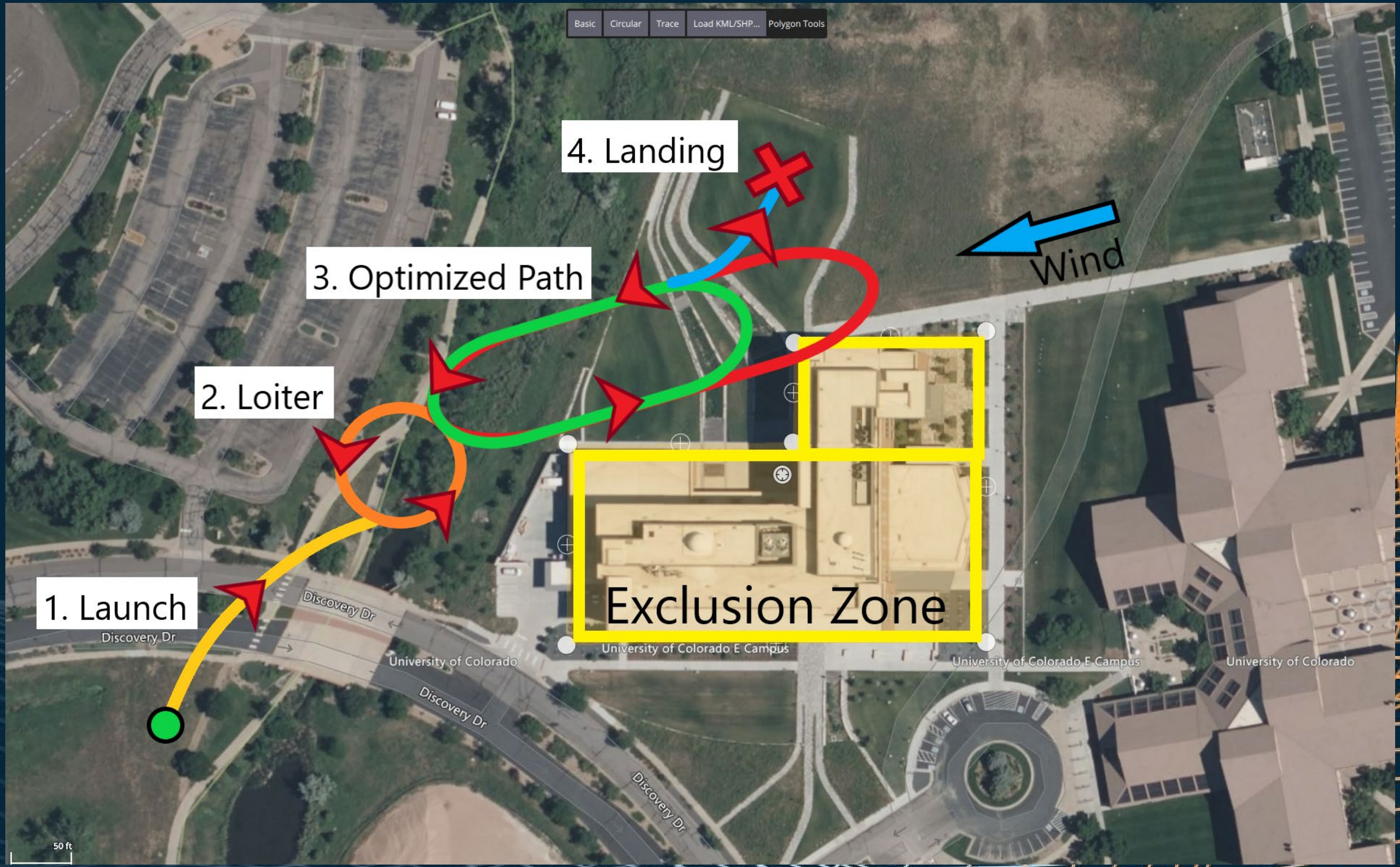
COMMUNICATION REQUIREMENTS

- Offboard mode
  - MAVLink messages and commands are received by simulation at > 2 Hz
  - Verified with Mode setting in QGroundControl and MAVLink message log file
- New Plan Generation
  - Optimized Path is generated in < 5 minutes after entering Loiter
  - Verified with elapsed time during execution in MATLAB



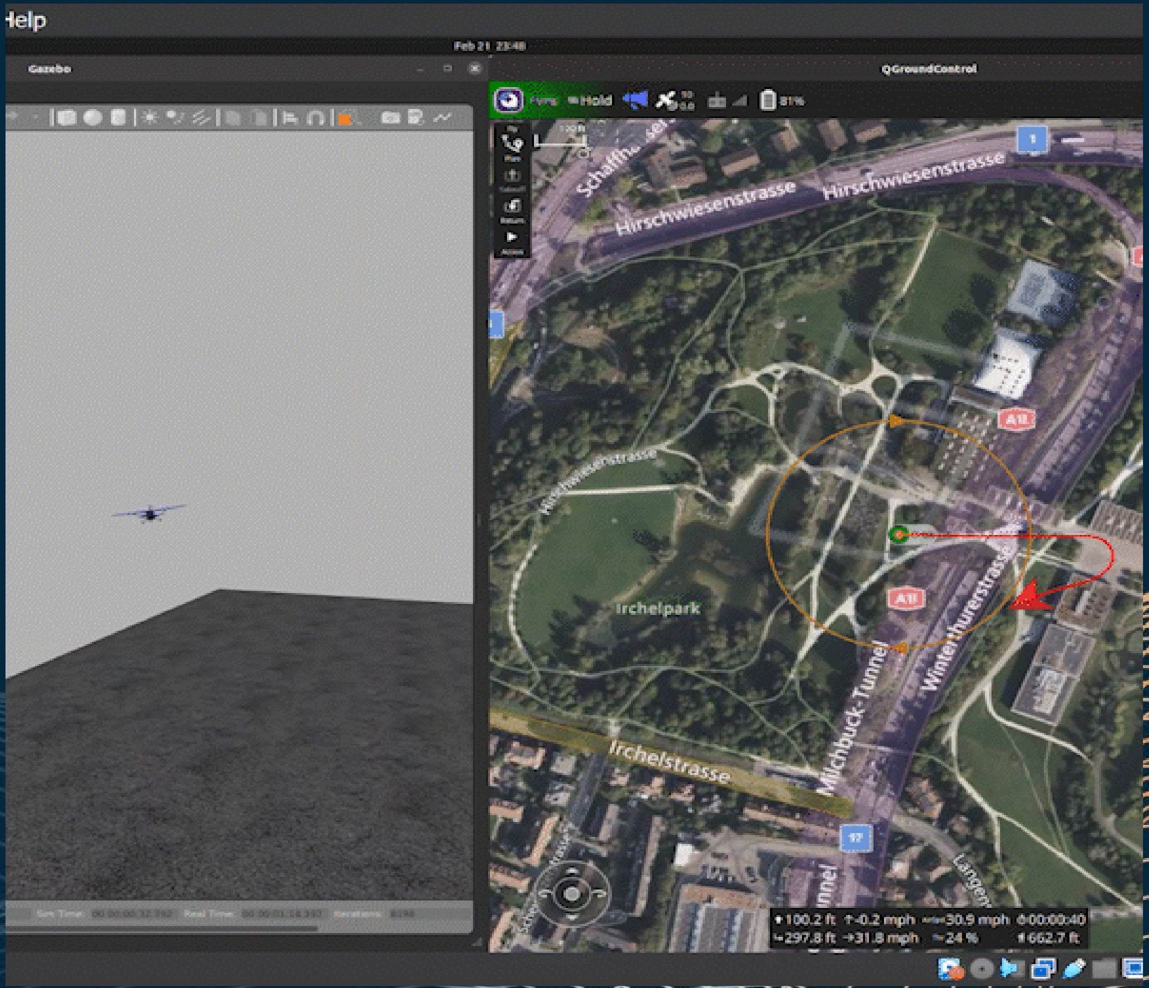
MISSION EXECUTION

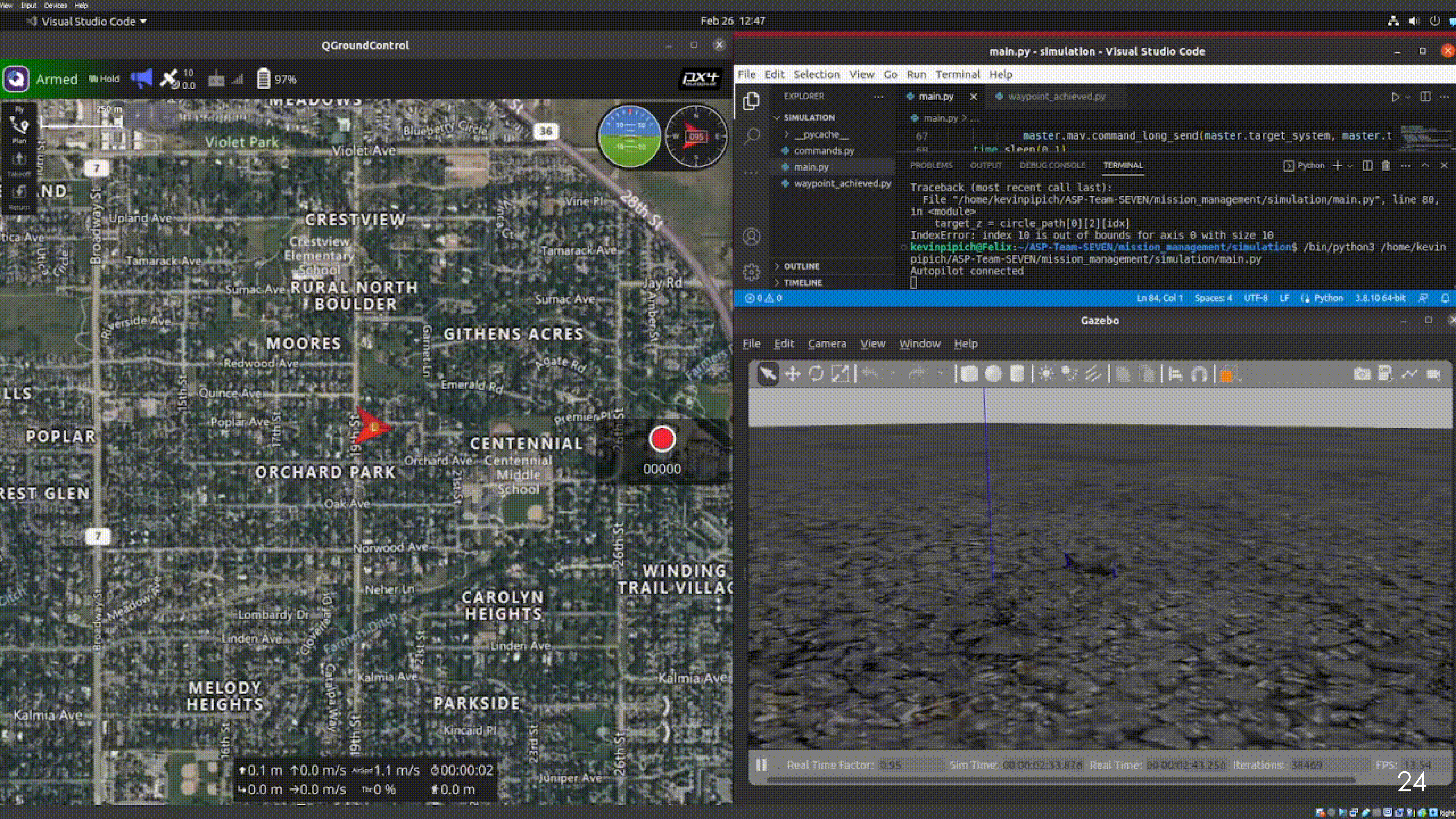
- Flight Tolerance
  - Aircraft navigates to within 20 meters of waypoints
  - Verified with simulated telemetry [x,y,z] data
- Autonomous Flight
  - The entire Software in the Loop test will be autonomous
  - Shows command of a full mission without operator intervention
- Flight Boundaries
  - Validates the safety of the project by disallowing unsafe trajectories
  - Allows user constraints to trajectory that can avoid dangerous areas



TEST EQUIPMENT/FACILITIES

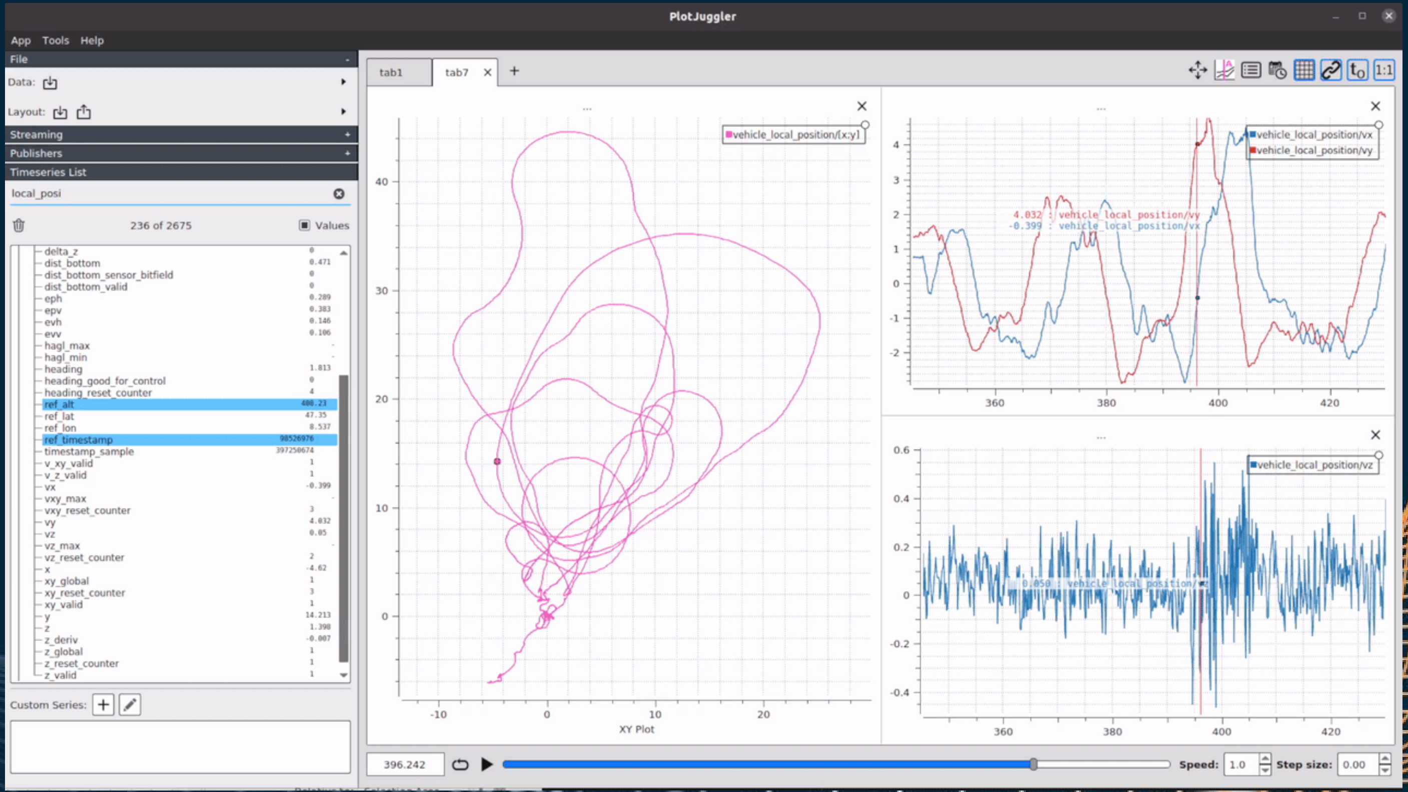
- Linux Computer running:
  - QGroundControl
  - PX4 Software-in-the-Loop Gazebo Simulation
  - MATLAB script (path generation)
  - Python script (MAVLink messages)
- Safety
  - There are no safety risks for this test, as it is all simulated on a computer.




Visual Studio Code
Feb 26 12:47
QGroundControl
Armed
Hold
97%
Violet Park
Violet Ave
CRESTVIEW
Crestview Elementary School
RURAL NORTH BOULDER
MOORES
GITHENS ACRES
POPLAR
ORCHARD PARK
CENTENNIAL
Centennial Middle School
REST GLEN
WINDING TRAIL VILLAG
CAROLYN HEIGHTS
MELODY HEIGHTS
PARKSIDE
00000
0.1 m 0.0 m/s 1.1 m/s 00:00:02
0.0 m 0.0 m/s 0 % 0.0 m
main.py - simulation - Visual Studio Code
File Edit Selection View Go Run Terminal Help
EXPLORER
SIMULATION
__pycache__
commands.py
main.py
waypoint_achieved.py
OUTLINE
TIMELINE
master.mav.command_long_send(master.target_system, master.t
time.sleep(0.1)
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL
Traceback (most recent call last):
File "/home/kevinpipich/ASP-Team-SEVEN/mission_management/simulation/main.py", line 80, in <module>
target_z = circle_path[0][2][idx]
IndexError: index 10 is out of bounds for axis 0 with size 10
kevinpipich@Felix:~/ASP-Team-SEVEN/mission_management/simulation$ /bin/python3 /home/kevinpipich/ASP-Team-SEVEN/mission_management/simulation/main.py
Autopilot connected
Ln 84, Col 1 Spaces: 4 UTF-8 LF Python 3.8.10 64-bit
Gazebo
File Edit Camera View Window Help

DATA ACQUISITION

- Flight telemetry data and MAVLink message logs will be downloaded from QGroundControl as a .ulg log file.
- Log file analyzed using the PlotJuggler data visualizer.
- Data exported as csv from PlotJuggler for further analysis.



PlotJuggler gif courtesy of the PX4 User Guide
https://docs.px4.io/main/en/log/plotjuggler_log_analysis.html

FLIGHT TEST – POWER CURVE TESTING

TEST OVERVIEW

Main Goals

1. **Validate power vs. airspeed shape from Tempest model**
2. **Satisfy high level mission objectives**
   - Generate full system power curve (power draw vs. airspeed)
   - Determine operable airspeeds
   - Determine stall safety margins

TESTING RATIONALE

Power Curve Model Validation

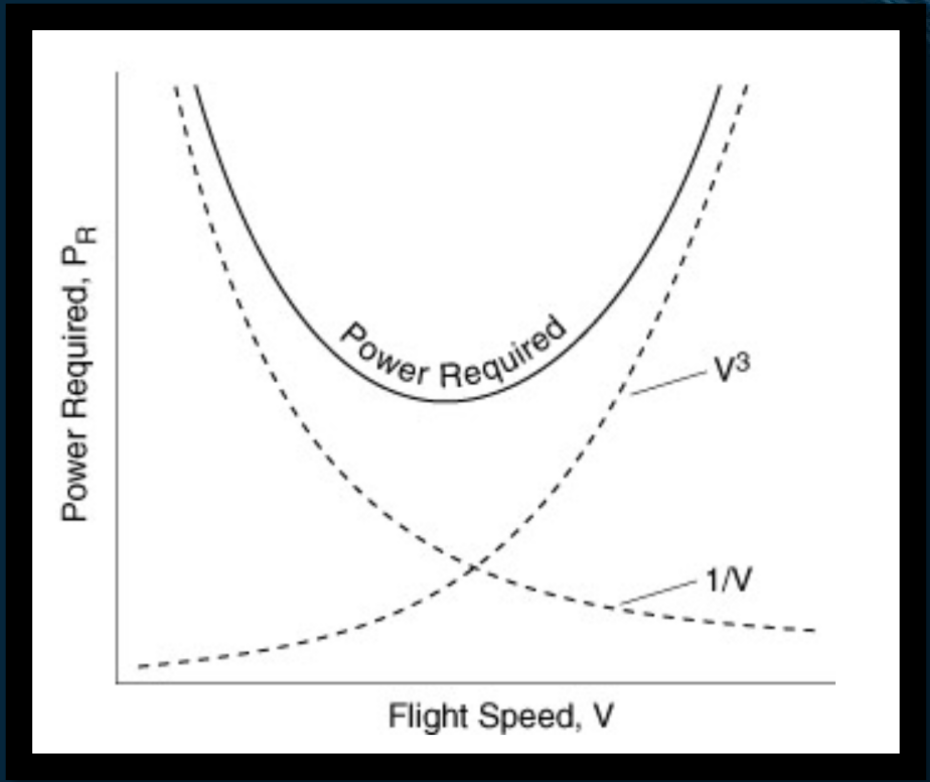
- Generate full system power curve
- Compare to Tempest model

Range of Operable Airspeeds

- **20% endurance improvement** (DR 2.1)
- Monitor battery voltage [V] and current [mA] (DR 2.1.2)

Monitor Stall Conditions

- Incorporate safety margins to avoid stall
  - Minimum commanded speed must be at least **1.5X stall velocity** (DR 2.1.1)
- Validate mission objective for flight safety



$$P_{req} = \frac{1}{2}\rho V^3 S C_{D_o} + \frac{W^2}{\frac{1}{2}\rho V S}\left(\frac{1}{\pi e AR}\right)$$

Aerodynamic Power Only

PREREQUISITE TESTING

Airspeed Sensor Verification Test

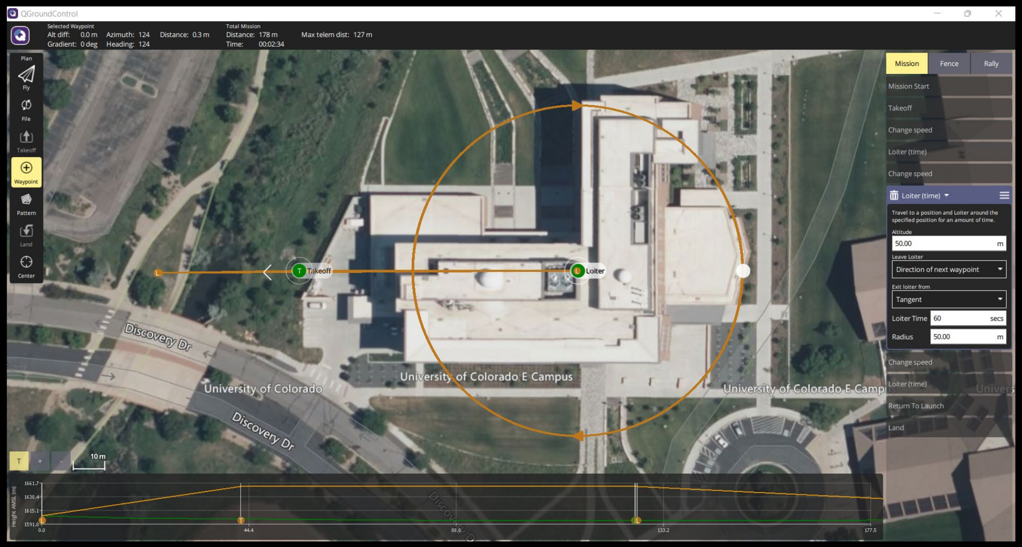
- Accuracy and reliability
- True airspeed vs. indicated airspeed
    - Adjust for air density?

$$V_{\infty,sl} = \sqrt{\frac{2(P_0 - P)}{\rho_{sl}}}$$

$$V_{\infty,boulder} = \sqrt{\frac{\rho_{sl}}{\rho_{boulder}}}\sqrt{\frac{2(P_0 - P)}{\rho_{sl}}}$$

Preplanned Waypoint Sequence Flight Test

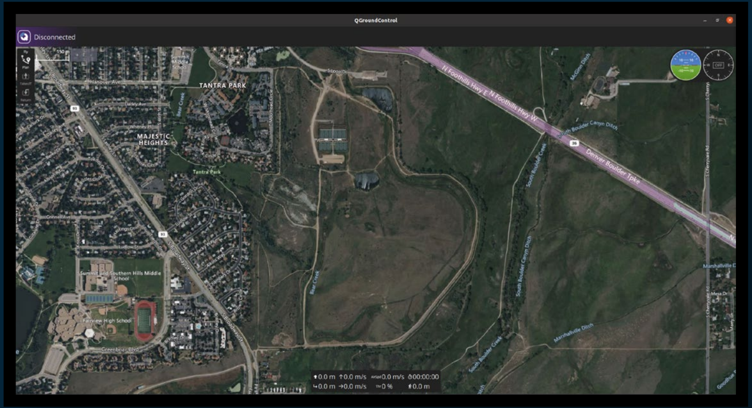
- Testing PX4's ability to fly autonomously and follow waypoints
- Data logging functionality
- Testing telemetry downlinking
    - Reliability, data rates, accuracy



EQUIPMENT AND FACILITIES

Equipment and Facilities

- Ground station laptop (with QGC)
- Handheld RC controller (and pilot)
- CU Boulder South (Facility)
- Phoenix 2400 (with sensors)



Safety Procedures - Special Flight Release (SFR)

- Fly at <500 ft AGL
- Bring safety equipment to test site
  - Fire extinguisher, sand bucket, replacement parts, etc.
- Pre-flight checklist and equipment inspection
- Monitor weather (winds <5 knots, clear skies, etc.)
- Constant LOS and stand-by for manual control

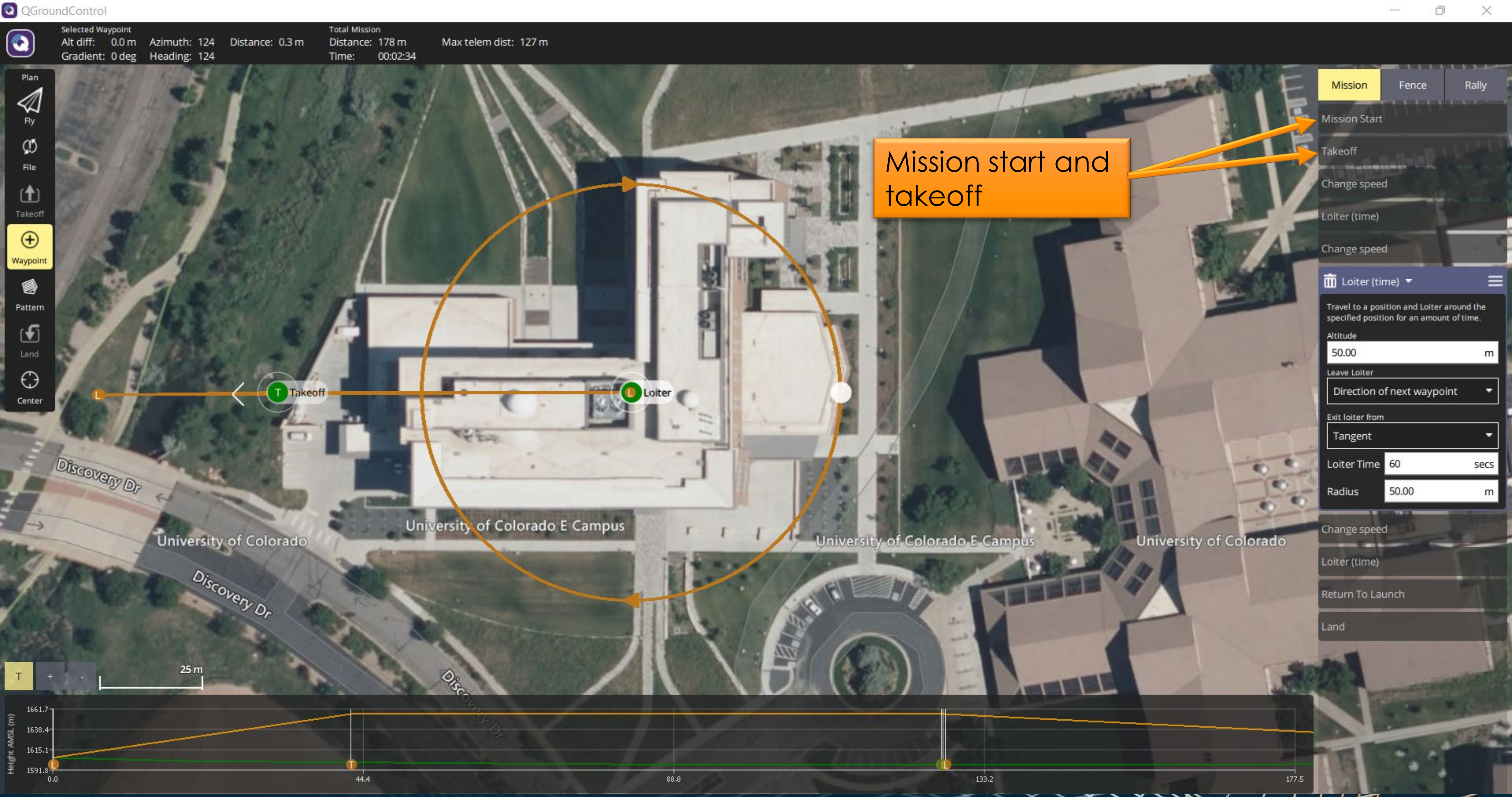
DATA ACQUISITION

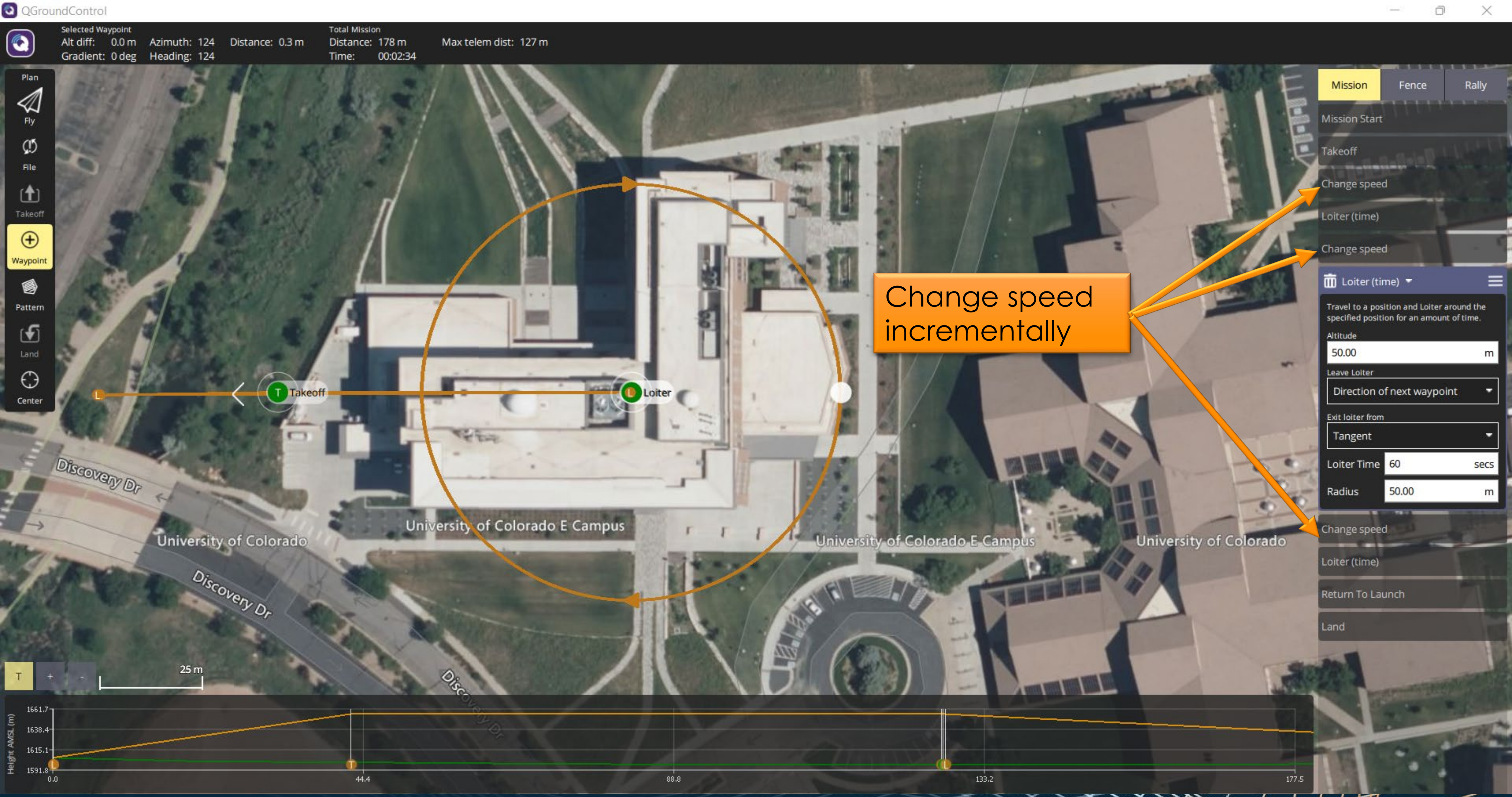
Sensors / Data Acquisition

- Airspeed sensor
- Holybro PM02 power module
  - Measures battery voltage and current
- Default logging functionality within PX4
  - MAVLink Messages to QGC
  - 50 KB/s @ 50 Hz

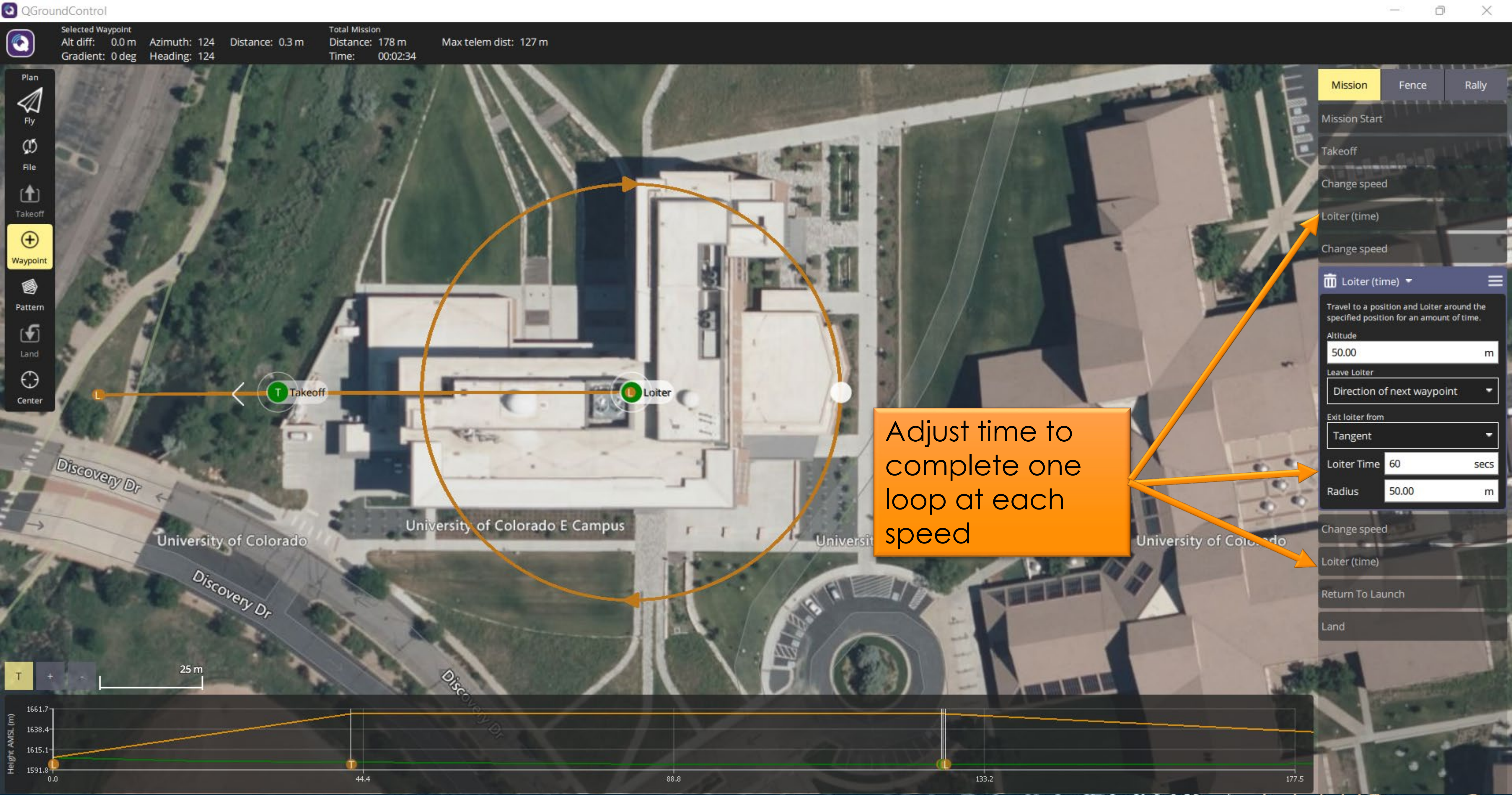
Overview of Procedures

- Build flight path in QGroundControl
- Fly path at different speeds, collecting airspeed and battery data
- Download MAVLink message logs


QGroundControl
Selected Waypoint
Alt diff: 0.0 m
Gradient: 0 deg
Azimuth: 124
Heading: 124
Distance: 0.3 m
Total Mission
Distance: 178 m
Time: 00:02:34
Max telem dist: 127 m
Plan
Fly
File
Takeoff
Waypoint
Pattern
Land
Center
Mission start and takeoff
Mission
Fence
Rally
Mission Start
Takeoff
Change speed
Loiter (time)
Change speed
Loiter (time)
Travel to a position and Loiter around the specified position for an amount of time.
Altitude
50.00 m
Leave Loiter
Direction of next waypoint
Exit loiter from
Tangent
Loiter Time 60 secs
Radius 50.00 m
Change speed
Loiter (time)
Return To Launch
Land
Takeoff
Loiter
Discovery Dr
University of Colorado
University of Colorado E Campus
25 m
Height AMSL (m)
1661.7
1638.4
1615.1
1591.8
0.0
44.4
88.8
133.2
177.5



Change speed incrementally


QGroundControl
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Alt diff: 0.0 m Azimuth: 124 Distance: 0.3 m
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Plan
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University of Colorado
University of Colorado E Campus
Mission
Fence
Rally
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Change speed
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Change speed
Loiter (time)
Travel to a position and Loiter around the specified position for an amount of time.
Altitude
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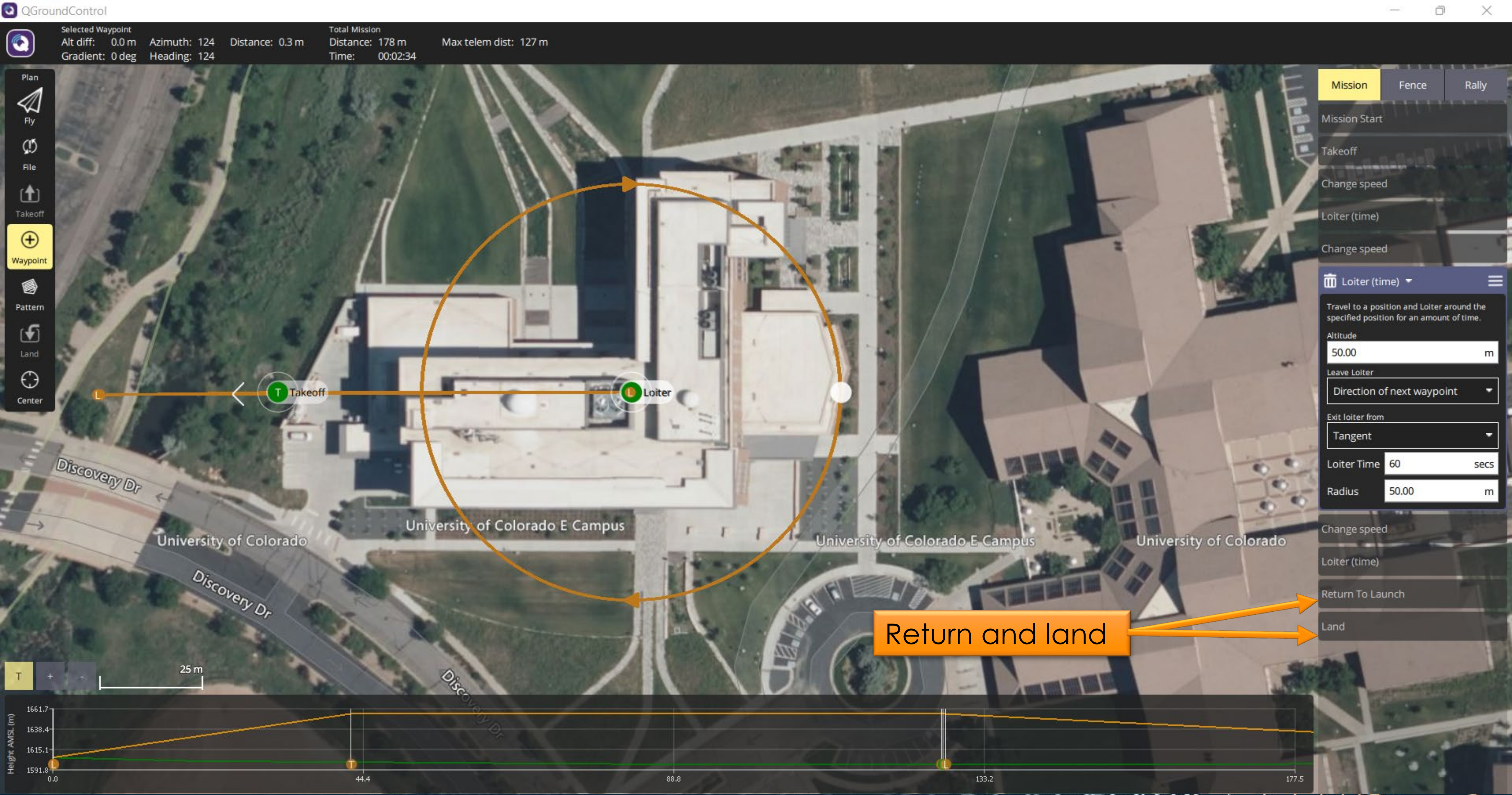
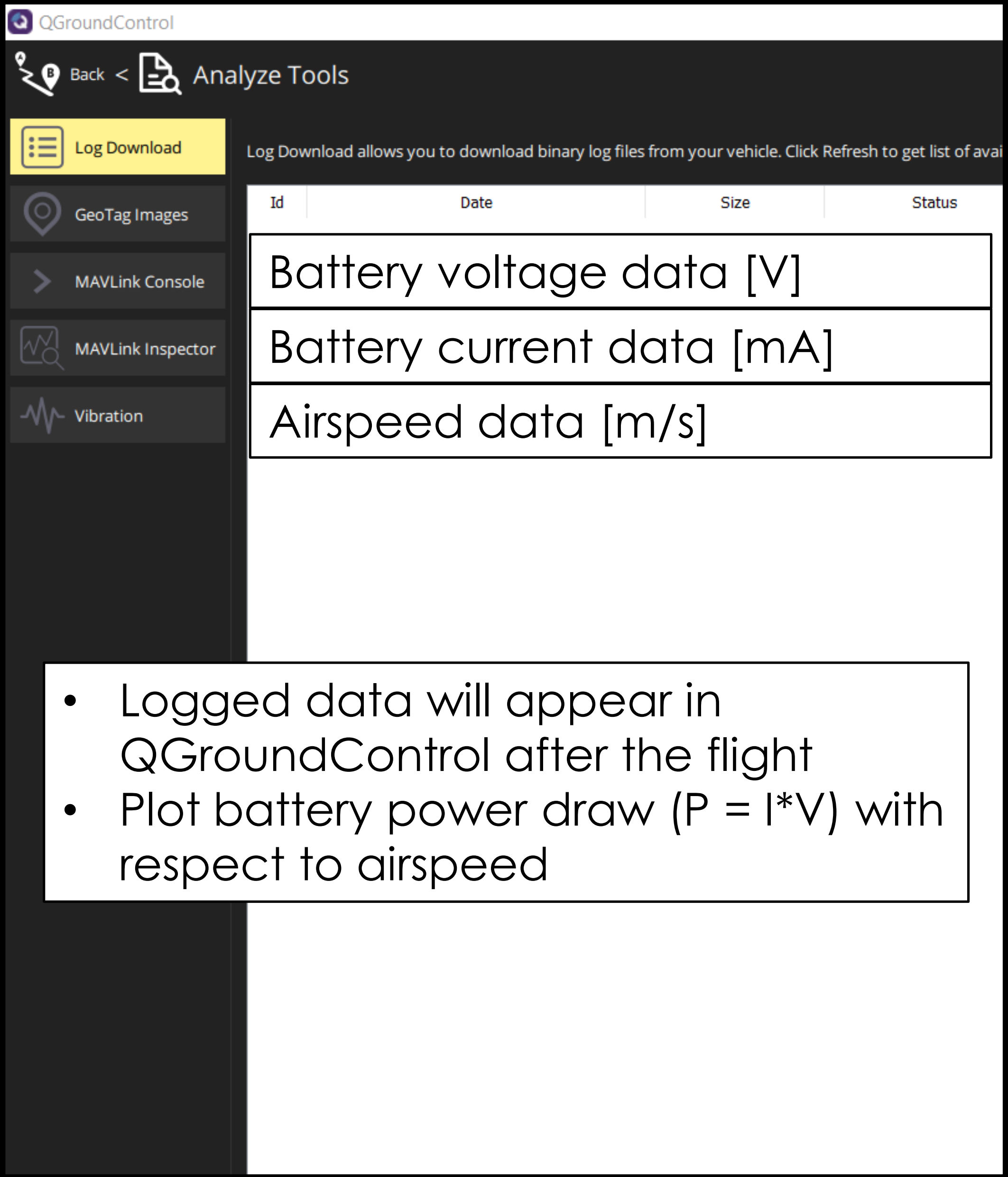
Leave Loiter
Direction of next waypoint
Exit loiter from
Tangent
Loiter Time 60 secs
Radius 50.00 m
Change speed
Loiter (time)
Return To Launch
Land
Adjust time to complete one loop at each speed
25 m
Height AMSL (m)
1661.7
1638.4
1615.1
1591.8
0.0
44.4
88.8
133.2
177.5

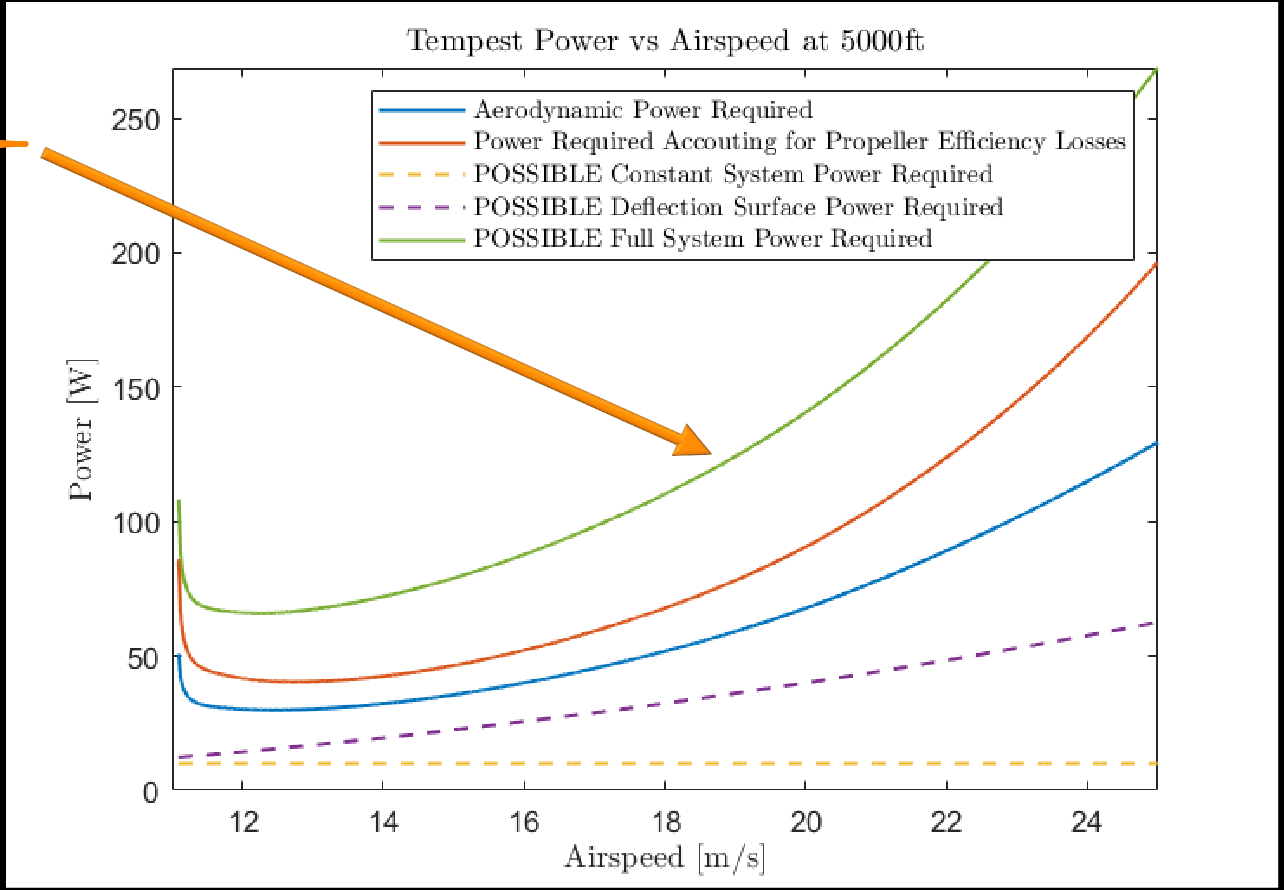

QGroundControl
Selected Waypoint
Alt diff: 0.0 m
Gradient: 0 deg
Azimuth: 124
Heading: 124
Distance: 0.3 m
Total Mission
Distance: 178 m
Time: 00:02:34
Max telem dist: 127 m
Plan
Fly
File
Takeoff
Waypoint
Pattern
Land
Center
Mission
Fence
Rally
Mission Start
Takeoff
Change speed
Loiter (time)
Change speed
Loiter (time)
Travel to a position and Loiter around the specified position for an amount of time.
Altitude
50.00 m
Leave Loiter
Direction of next waypoint
Exit loiter from
Tangent
Loiter Time 60 secs
Radius 50.00 m
Change speed
Loiter (time)
Return To Launch
Land
Return and land
Takeoff
Loiter
Discovery Dr
University of Colorado
University of Colorado E Campus
25 m
Height AMSL (m)
1661.7
1638.4
1615.1
1591.8
0.0
44.4
88.8
133.2
177.5

EXPECTED RESULTS



- Battery voltage data [V]
- Battery current data [mA]
- Airspeed data [m/s]

- Logged data will appear in QGroundControl after the flight
- Plot battery power draw (P = I*V) with respect to airspeed



EXPECTED RESULTS

Evaluation	Criteria	Mission Objective
Power curve can be generated from test flight	**Pass/Fail**: Aircraft must return battery and airspeed data	• Endurance Improvement • DR 2.1.2 (monitor battery current and voltage)
Power curve validates Tempest model	**Pass/Fail**: The power curve resembles a typical parabola shaped power curve	• Endurance Improvement • Model Validation
Operable airspeeds are determined from power curve	**Pass/Fail**: A range of operable airspeeds are available from the power curve	• DR 2.1* (+20% from baseline) • Endurance Improvement
Stall event monitoring (> 1.5X stall velocity requirement met)	**Pass/Fail**: Stall does not occur due to 1.5X stall speed minimum allowed speed	• 2.1.1* (>1.5x stall velocity) • Flight Safety

*These requirements are not validated yet. Instead, this test lays the groundwork for them to be validated in the finished ground station code.

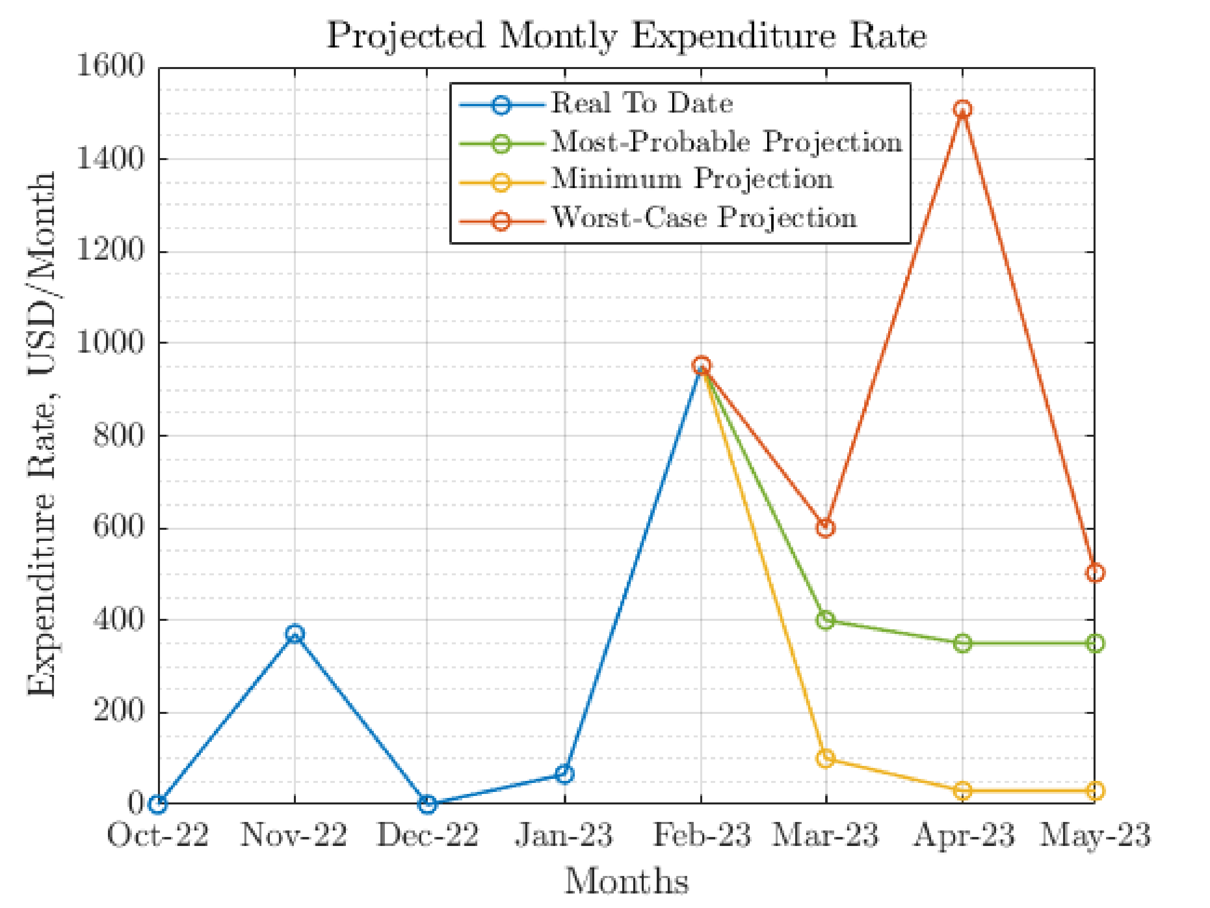
PROJECT BUDGET

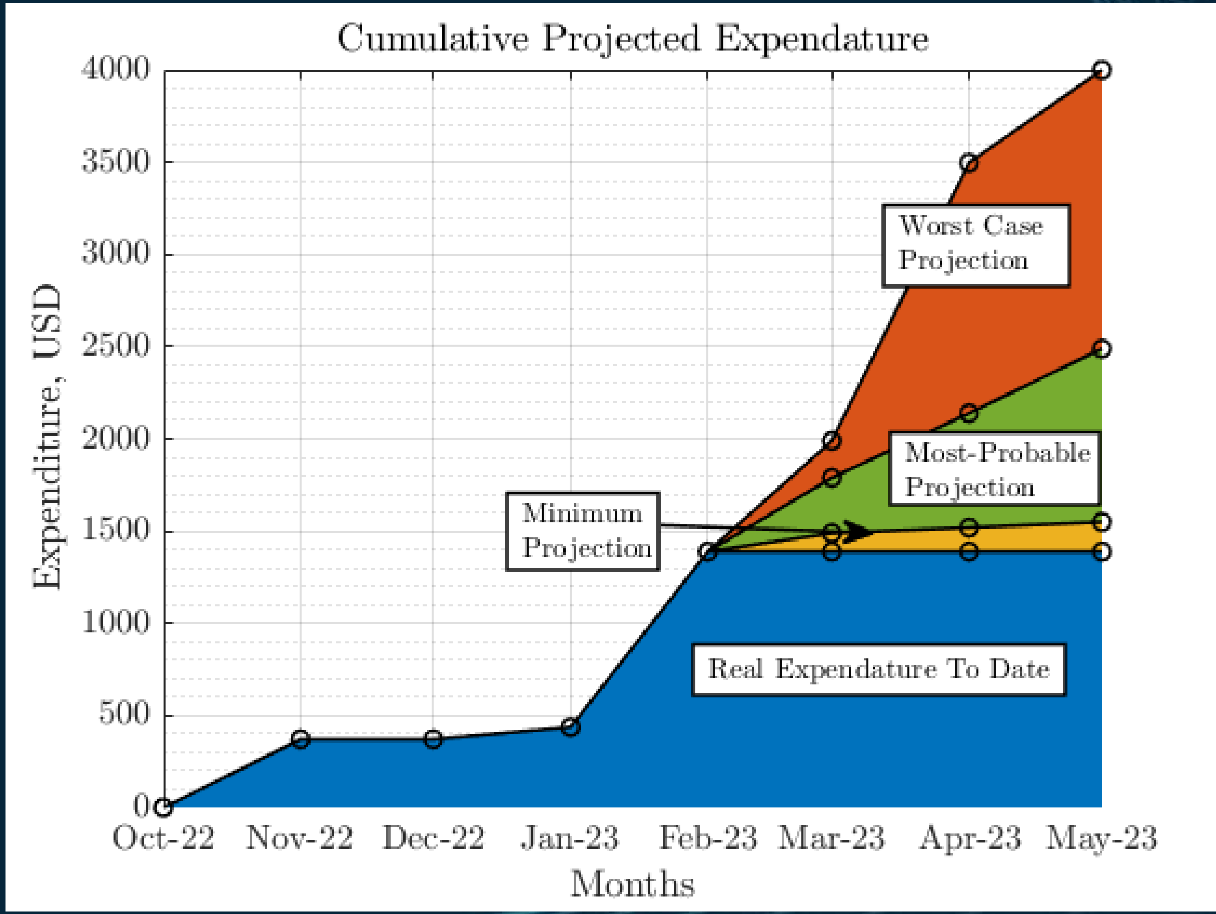
Cost Plan – Real Expenditure

- Current budget allocation: $1,528
- Current real expenditure: $1,389
- Remaining budget: $2,411

Subsystem	Item	Cost	Purchased	Received	Purchase Window
RC Control	Zee 3200 2-Pack Battery	$ 43.99	Y	Y	Nov-22
	Battery for TX16s	$ 24.50	Y	Y	
	RadioMaster TX16s	$ 219.99	Y	Y	
	FRSKY SPort tool	$ 15.90	Y	Y	
	FrSky S8R Receiver	$ 57.99	Y	Y	
	XT60 Connectors	$ 7.99	Y	Y	
	Additional wires, batteries, bits, etc	$ -			
	Total:	**$ 370.36**			
Companion Computer	BeagleBone Rev C	$ 65.99	Y	Y	Jan-23
	Total:	**$ 65.99**			
Flight Computer	Pixhawk 6c + PM07	$ 349.99	Y	X	Jan-23 to March-23
	M8N GPS	$ 59.99	Y	X	
	Power Module 02	$ 18.99	Y	X	
	Better Antennas	$ 234.00	Y	X	
	Additional Sensors				
	Additional wires, batteries, bits, etc				
	Total:	**$ 648.97**			
Airframe	Replacement Parts				Jan-23 to May-23
	Running Costs				
	Total:	**$ -**			
Safety Equipment	CO_2 Class BC Fire Extinguisher	$ 204.00	Y	Y	Feb-23 to April-23
	Class ABC Fire Extinguisher	$ 144.00	X	X	
	Ground wind speed sensor equipment	$ 80.50	Y	X	
	Total:	**$ 428.50**			
	Overall Total:	**$ 1,513.82**			

Cost Plan – Projected Expenditure





Overview | Schedule | Simulation Test | Flight Test | Budget

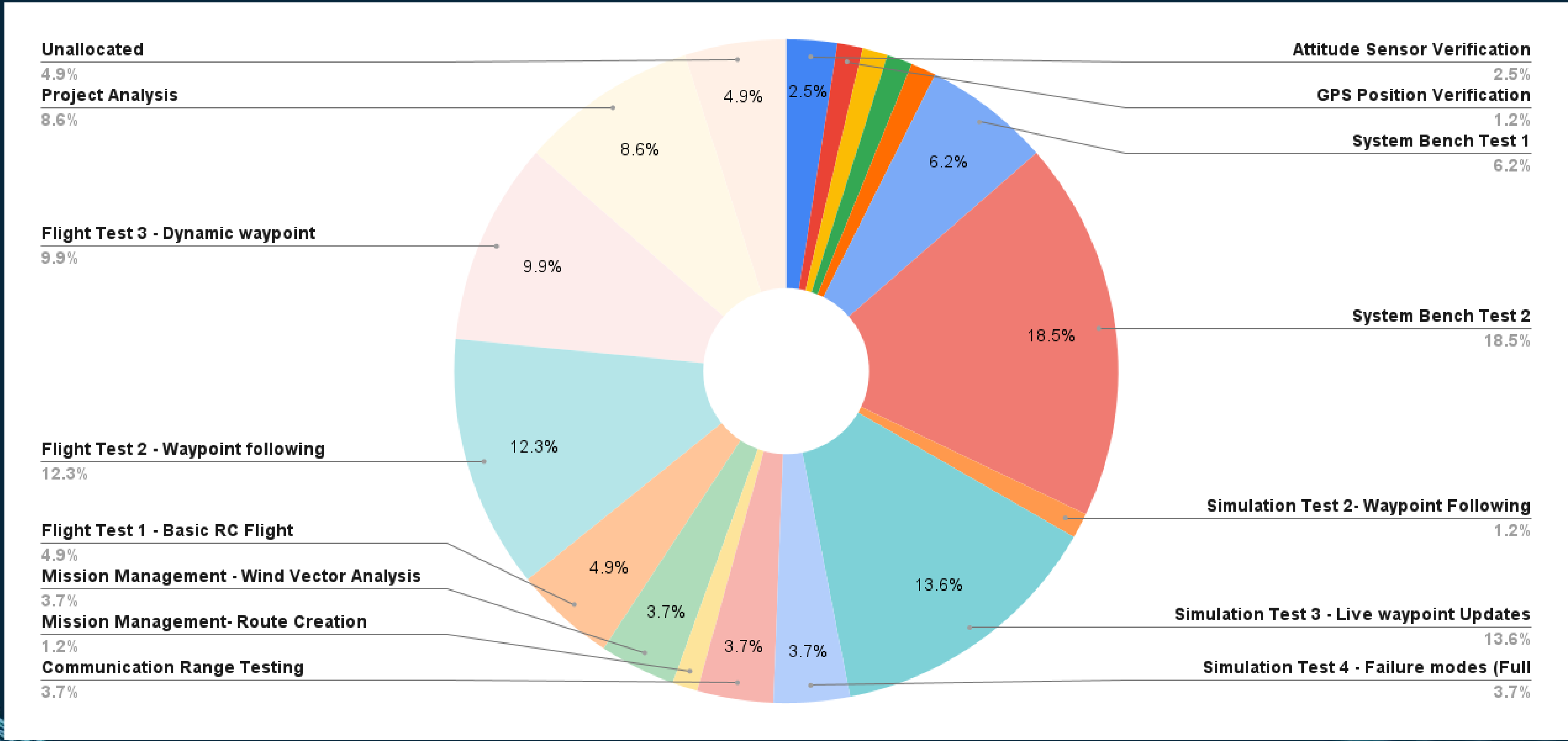
QUESTIONS?

Table of Contents

Functional Requirements

FR #	Requirement
1	The UAS shall be capable of receiving commands and transmitting telemetry to and from a controller
2	The UAS shall manage aircraft trajectory based on energy state and specified mission parameters to improve flight endurance
3	Flight operation shall minimize user workload and need for active user input throughout its entire mission profile
4	The UAS shall adhere to all relevant guidelines and implement measures to protect the safety of the UAS itself as well as people and objects in the surrounding area
5	The UAS shall be fully operational in austere environments with the ability to adapt to varied conditions and remain in a continual standby posture when unused
6	The initial cost and complexity for users to assemble, configure, operate, and maintain the UAS system shall be minimized and shall seek to significantly undercut prices of existing long endurance drone systems

TEST EVENT ALLOCATION



SIMULATION TEST
HIGH LEVEL REQUIREMENTS

Message Transmission

- Telemetry from UAS to GS
  - 1.2
  - 1.2.3
  - 1.7
  - 1.7.1
- Flight plan from GS to UAS
  - 1.3

Waypoint Generation

- Valid path to target point
  - 2.2.1
  - 2.2.4
- Obstacle avoidance
  - 2.2.2
  - 2.2.3
- Valid orbit
  - 2.2.7
- Generation every 5 minutes
  - 2.3.2

Autopilot Capability

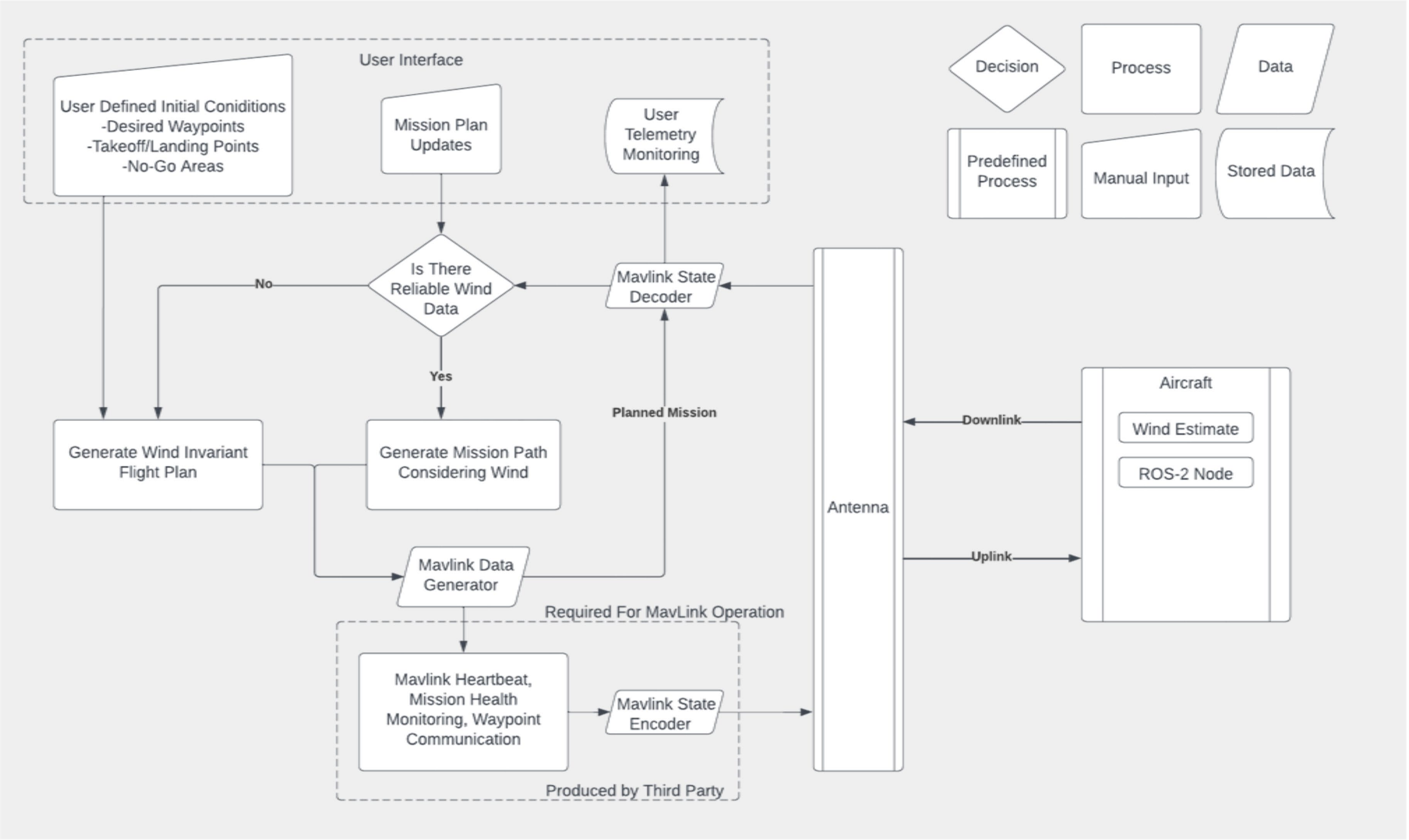
- UAS executes waypoint path
  - 1.4.2
  - 5.3.1
- Autonomous Flight mission objective
- Flight Boundaries mission objective

SIMULATION TEST CARD

TEST PROCEDURE	
1.	**Start** PX4 and Gazebo simulation by typing “make px4_sitl gazebo-classic_plane” in the terminal of the PX4-Autopilot folder.
2.	**Launch** QGroundControl app image
3.	**Ensure** QGroundControl is connected to Gazebo simulation and aircraft mode is “Ready To Fly”
4.	Hardcode wind into Gazebo and MATLAB MM code, test to see if Topology code can generate an optimal path based on a known wind field.
5.	**Launch** vehicle manually and **place** into loiter pattern
6.	**Load** custom software to set PX4 into offboard mode, sending MAVLink messages at > 2Hz
7.	**Run** full flight plan
8.	**Collect** data and import into PlotJuggler
9.	**Analyze** data to ensure requirements are met, tweaking code as necessary
10.	**Record** results

FLIGHT TEST CARD

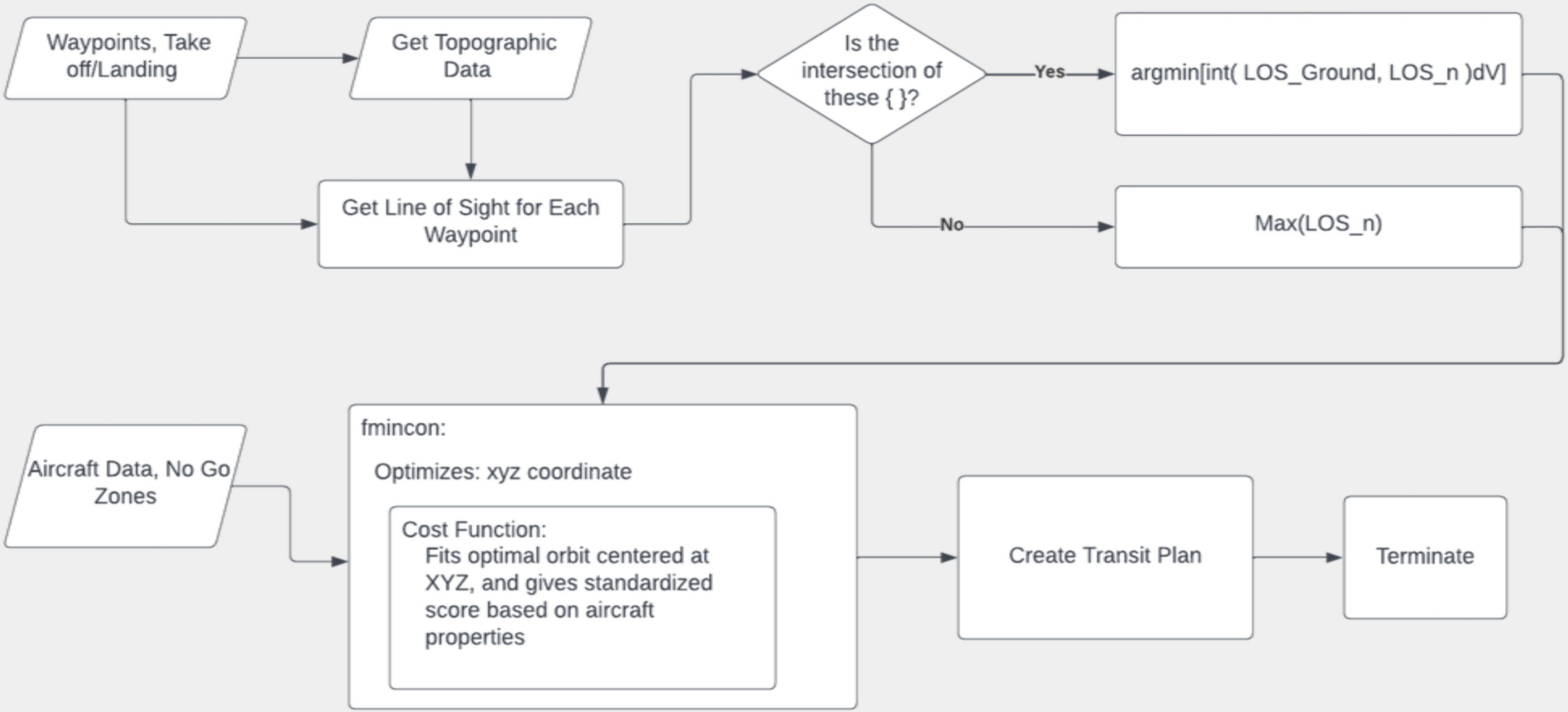
TEST PROCEDURE	
1.	**Ensure** winds to be uniform and calm using handheld anemometer (<5 knots, no greater deviation over 1 minute than 1.5 knots)
2.	**Connect** the PM02 PDB to the battery to power aircraft; connect aircraft to QGC; arm aircraft (logging will start when armed by default)
3.	**Complete** preflight checklist
4.	**Assign and upload** predefined waypoints and accompanying groundspeeds from QGroundControl to plane •The flight plan will be a large circle with each loop having a differing commanded airspeeds •Slow to high ground speeds and back to slow to account for differing motor and ESC efficiencies at changing battery voltages (decreasing during flight) •Will likely require two different tests since the battery may not last for the entire flight
5.	**Perform** a hand launch takeoff from within 20 m of the centroid of the flight region and fly aircraft in a holding pattern.
6.	**Enable** autonomous flight if QGC indicates adequate connection to drone.
7.	**Return** to manual control after the commanded flight plan has been achieved.
8.	**After** path testing is completed, retake control and perform a pseudo traffic pattern loop to line the aircraft up for landing. Ensure that a second go-around is not required and perform a landing within 30 meters of the centroid of the flight region (Prioritize a clear landing area that is well away from flight boundaries and potential crash hazards).
9.	**Download** telemetry log from QGC.
10.	**Compare** to measured voltages and current drawn from the battery at each point •Only use power draw from steady state (takes increase/decrease in power to accelerate/decelerate) •Data should be from all power drawn system wide – This is what we want


User Interface
User Defined Initial Coniditions
-Desired Waypoints
-Takeoff/Landing Points
-No-Go Areas
Mission Plan Updates
User Telemetry Monitoring
Decision
Process
Data
Predefined Process
Manual Input
Stored Data
Is There Reliable Wind Data
No
Yes
Mavlink State Decoder
Planned Mission
Antenna
Aircraft
Wind Estimate
ROS-2 Node
Downlink
Uplink
Generate Wind Invariant Flight Plan
Generate Mission Path Considering Wind
Mavlink Data Generator
Required For MavLink Operation
Mavlink Heartbeat, Mission Health Monitoring, Waypoint Communication
Mavlink State Encoder
Produced by Third Party
TEAM 7

Generate Wind Invariant Flight Plan

In: Waypoints, Take off/Landing points, No go zones, Aircraft Data, Loiter Times

Out: Flight Plan Vector



Generate Wind Informed Flight Plan

In: Waypoints, Take off/Landing points, No go zones, Aircraft Data, Loiter Times, wind data

Out: Flight Plan Vector