Lane-Based UAS Flight Operations

Tom Henderson & Chad Mello (!)

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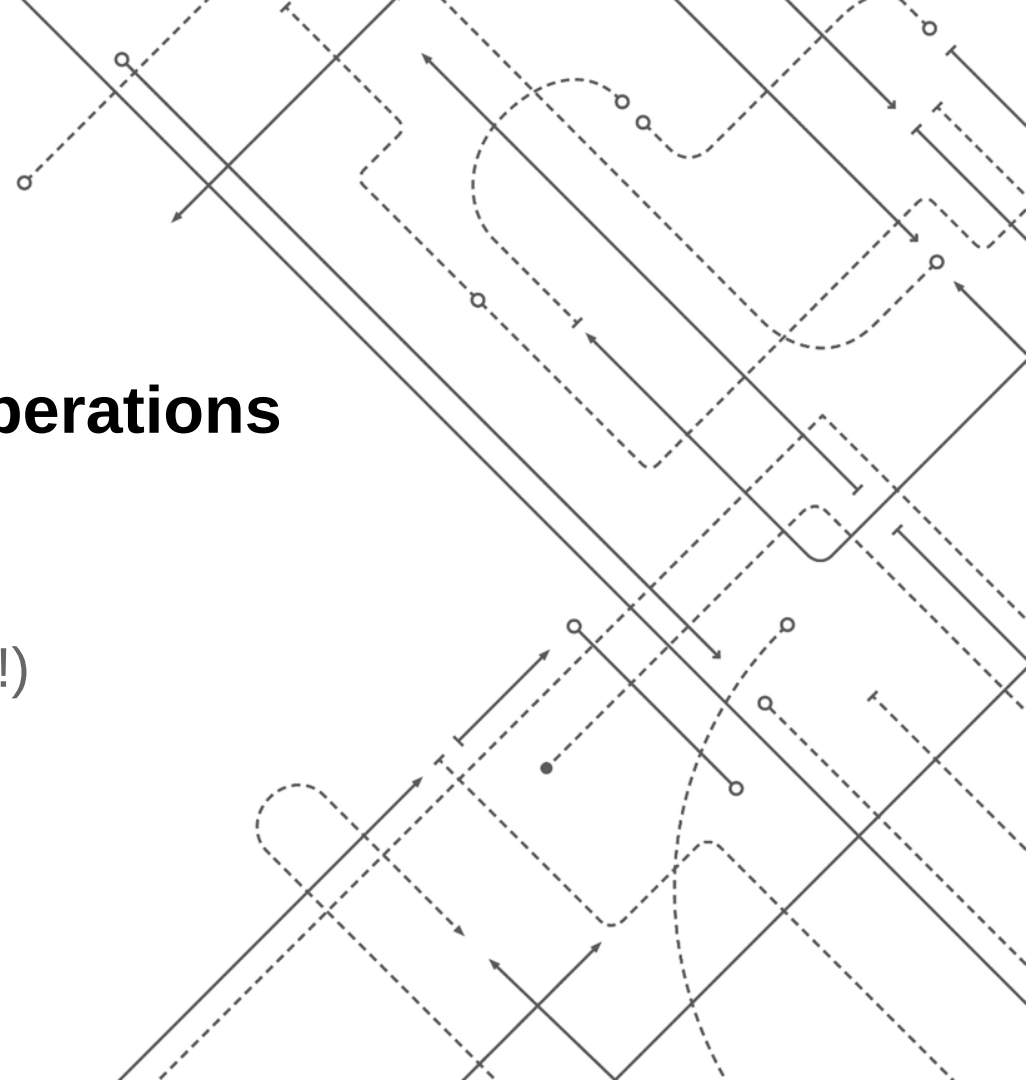
SCHOOL OF COMPUTING
THE UNIVERSITY OF UTAH



SFFP Proposed Work

Research Context: In the context of this fellowship, we propose to investigate the following items of interest from SF.04.19.B0002 Artificial Intelligence and Autonomous Vehicles:

- AF1. Leveraging artificial intelligence for automating a swarm of unmanned aerial systems to self correct in face of failure,
- AF2. Utilizing artificial intelligence search and automation for near real-time flight scheduling/rescheduling, and
- AF3. Integrating combat behaviors into a swarm of unmanned aerial systems.

Research Goals:

- **Goal 1**: Adapt the LEMANS contingency methods to AF1. Currently, LEMANS employs a variety of contingency handling approaches: changing speed, re-routing through the lane network, etc., but other approaches need to be studied, e.g., dynamic lane creation.
- **Goal 2**: Determine how well current LEMANS real-time scheduling and re-scheduling methods, work for Air Force scenarios of interest.
- **Goal 3**: Develop a framework to translate a combat mission statement into the selection of an appropriate set of platforms and behaviors to realize correct and robust swarm behavior.

SFFP Work

Method:

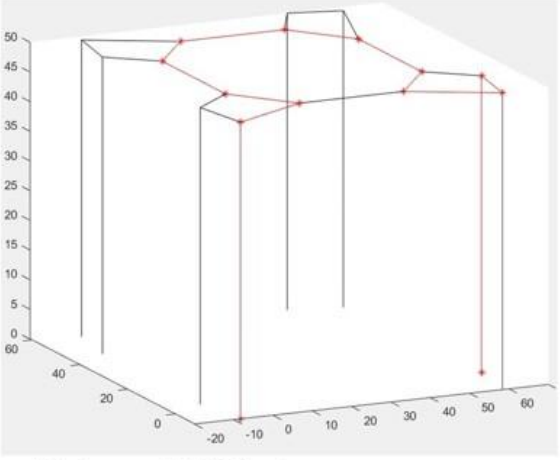
- Validate Lane Network in Practice through Experiments
  - Simple Single-UAS Mission
  - Complex Single-UAS Mission
  - Simple Two-UAS Mission
- Establish UTM Policies based on Experimental Data
- Evaluate Research Goals in terms of Lessons Learned
  - Contingencies
  - Mission Scenarios
  - Multi-platform team missions

Validate Lane Network in Practice through Experiments

Simple Single UAS Tests

Experiment 1 (11 June 2024, 13:34:04 and 13:42:41)

Planned Experiment:



Files:
AFA1a: airways
AFA1r: flight request
AFA1: flight data
AFA1_xyz: waypts in feet
AFA1_latlon: waypoints in GPS degrees
AFA1_xyz_meters: waypts in meters

Distance: 302.5 feet
Time: ~ 41.25 sec
Speed: 5 mph = 7.3335 fps = 2.2352508 mps
5 trials: 1,510 feet ~3.5 minutes

Experiment 1

Experiment: 11 June 2024, 13:34:04 and 13:42:41 by Chad Mello

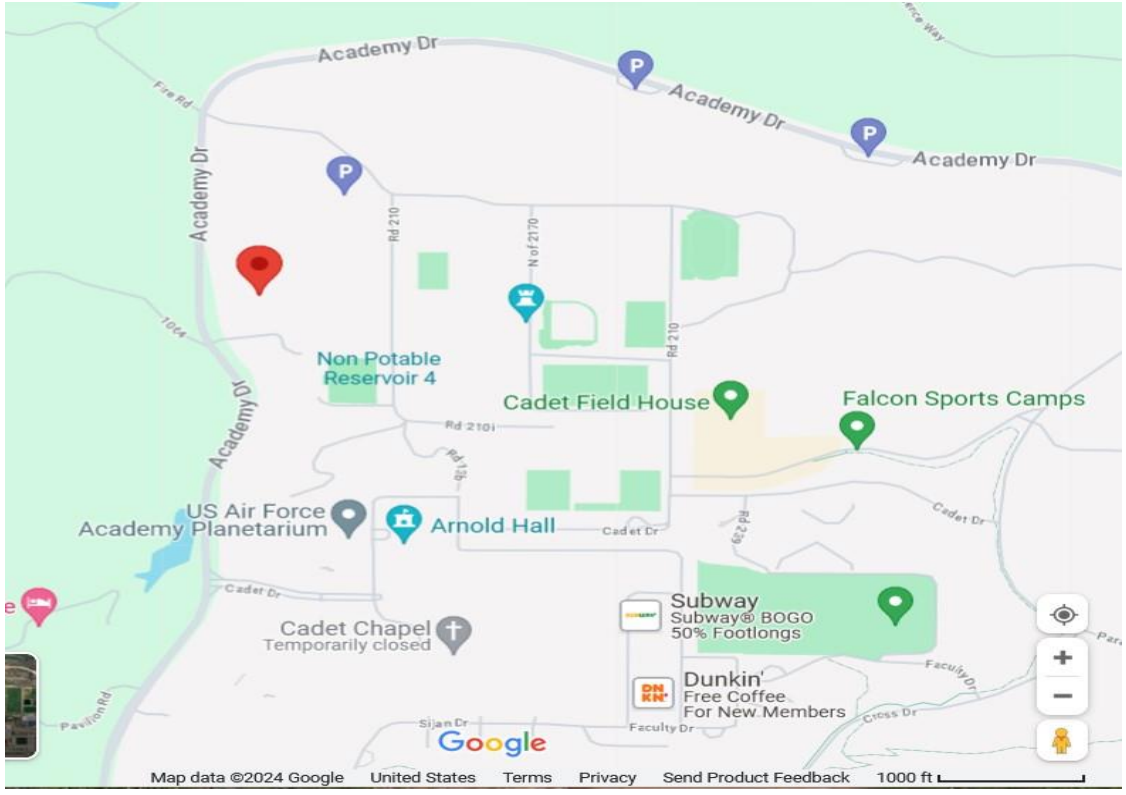
Chad performed two experiments of the route with parameters:

x spread 15m, y spread 15m, altitude 35m

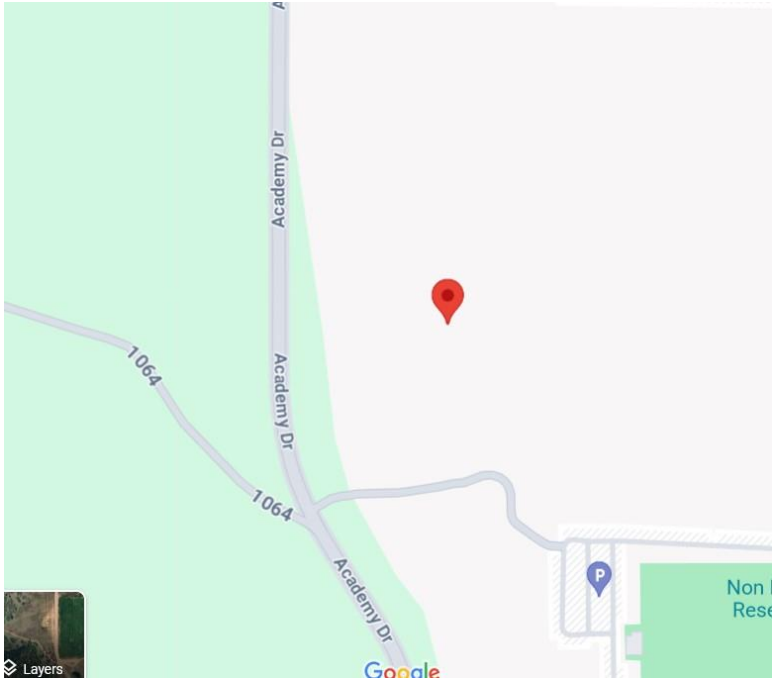
total distance about 115m.

However, the flight was disrupted at the end due ground obstructions and only sent telemetry data covering a distance of 86.093 m, and a time of 40.31 seconds with an average speed of 2.1358 mps. An analysis of the data is given below. First, the location and layout of the lane network is given.

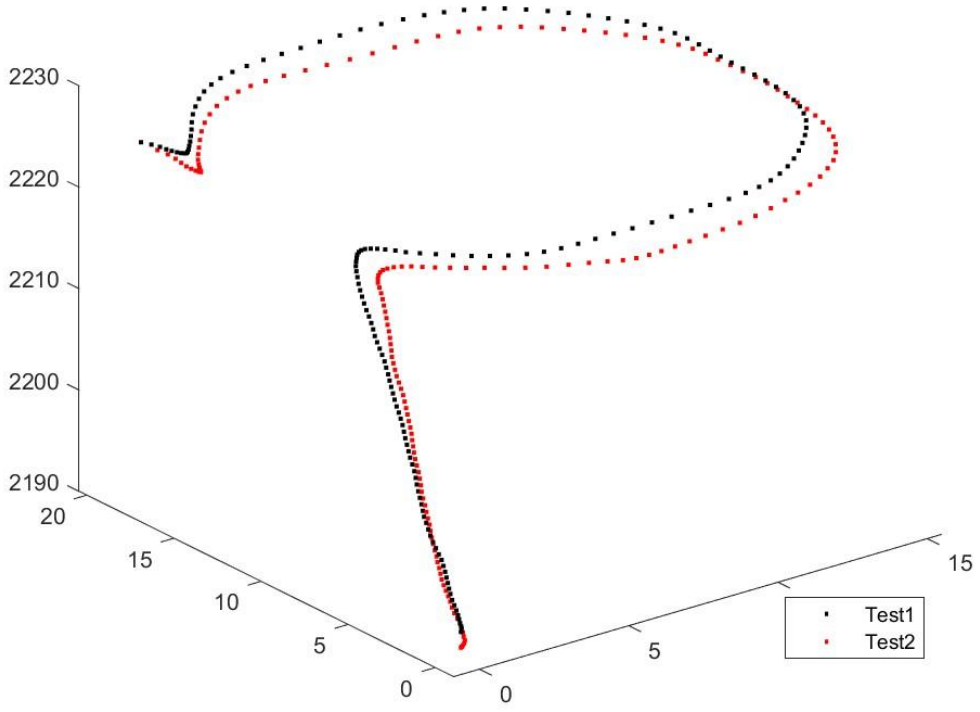
Experiment 1: Site



Experiment 1: Site



Experiment 1: Two Tests Overlayed



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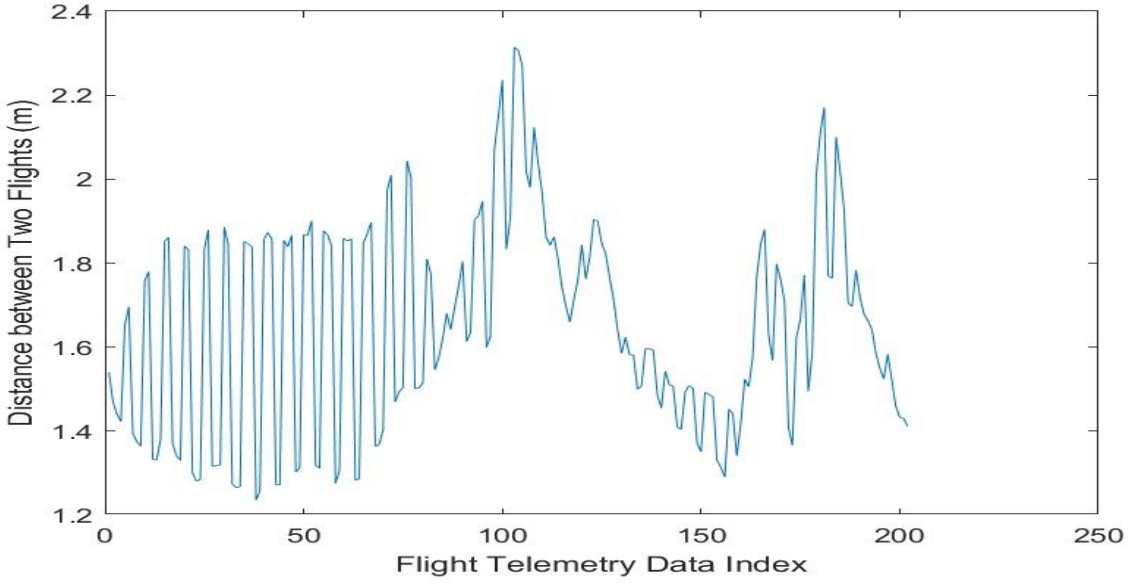
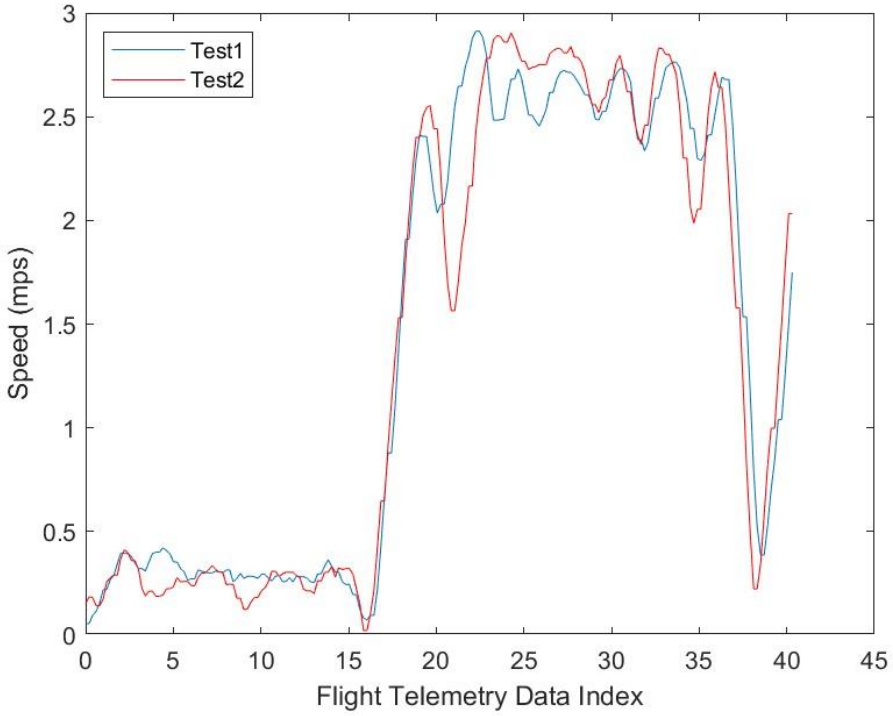
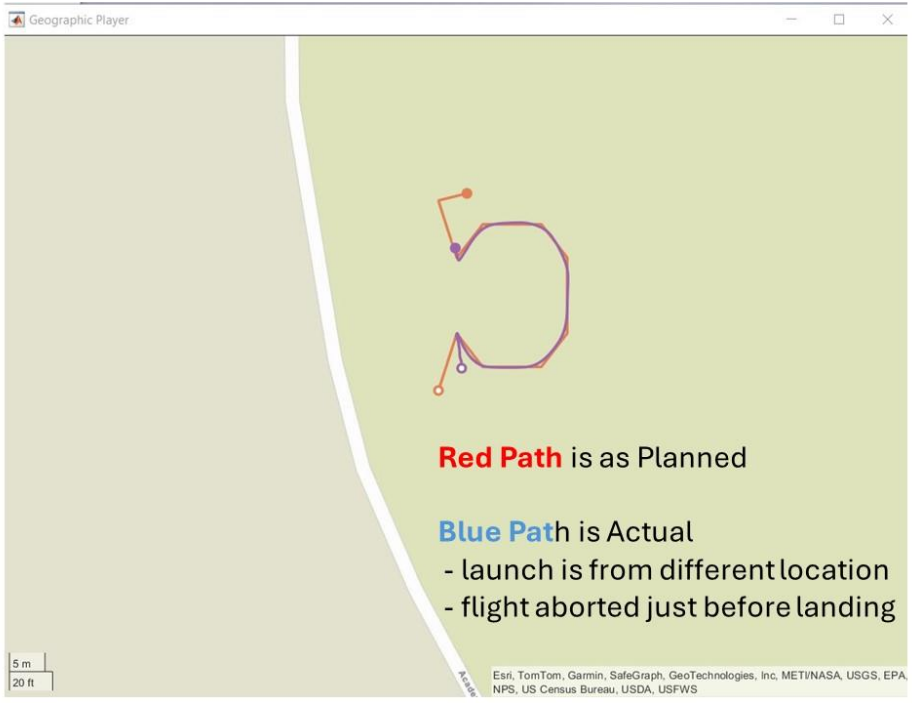
Experiment 1: Distance between the Flights



Experiment 1: Speeds of the Flights

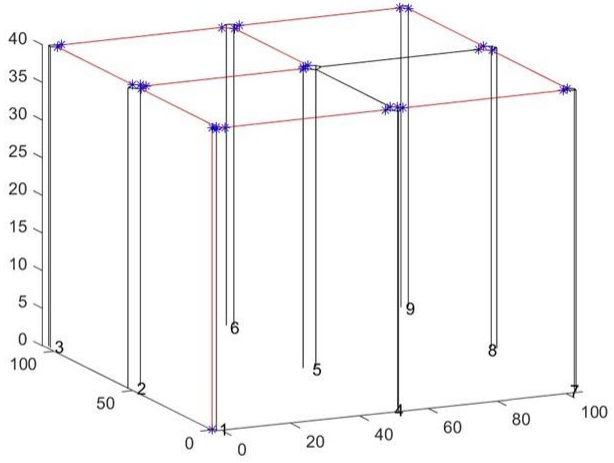


Experiment 1: Overlay of Planned & Actual on Map



Validate Lane Network in Practice through Experiments

Complex Single UAS Tests



Files:
complex1a: airways
complex1r: request
complex1: scenario data
complex1xyz_ft: waypts in ft
complex1xyz_m: waypts in Mercator coords in ft
complex1_latlon: waypts in lat lon alt time

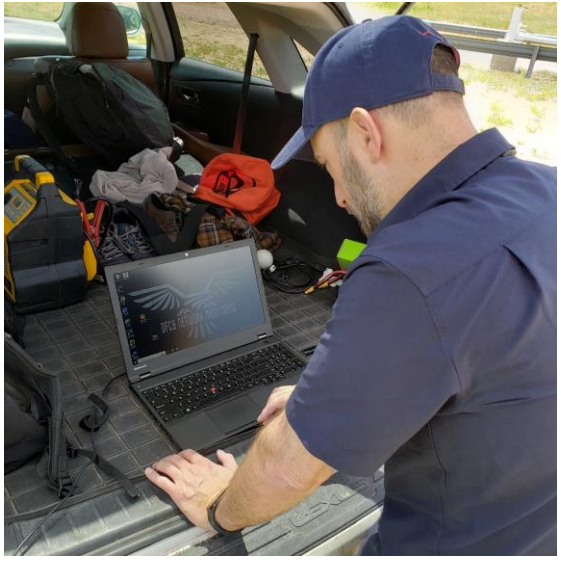
Mercator x,y origin in feet: [3.17157044293538,1.431251362416394]x10^6
Total time: 4.98 min
Total Distance: 70.65 feet = 215.1378 m)
Speed: 5mph = 7.335 fps = 2.2352508mps

Complex Single UAS Tests: Path on Map

Complex Single UAS Tests: Conditions

Flight Conditions (25 June 2024, ~10:30am):

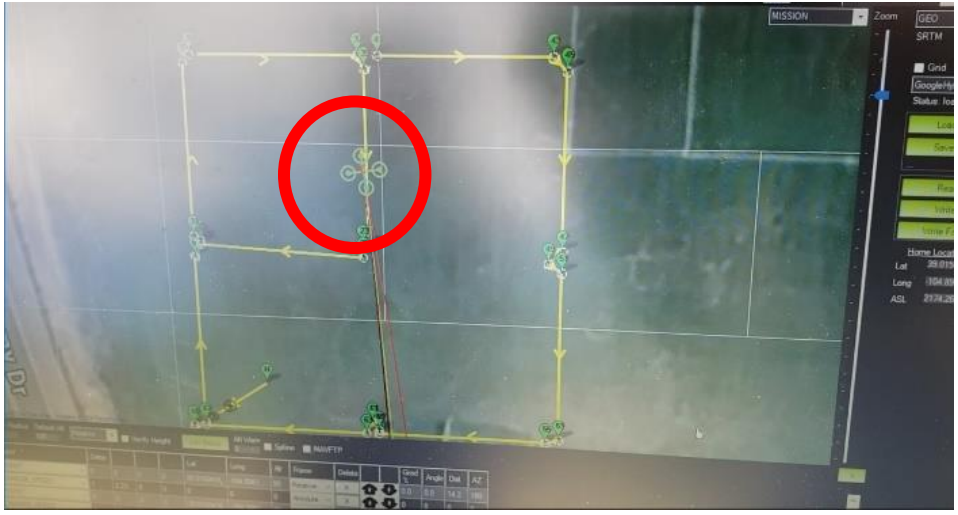
Temperature: ~89^{o}F Wind: ~ 5-8 mph; Chad Mello conducted the experiments



Complex Single UAS Tests: Flights

Complex Single UAS Tests: Flights

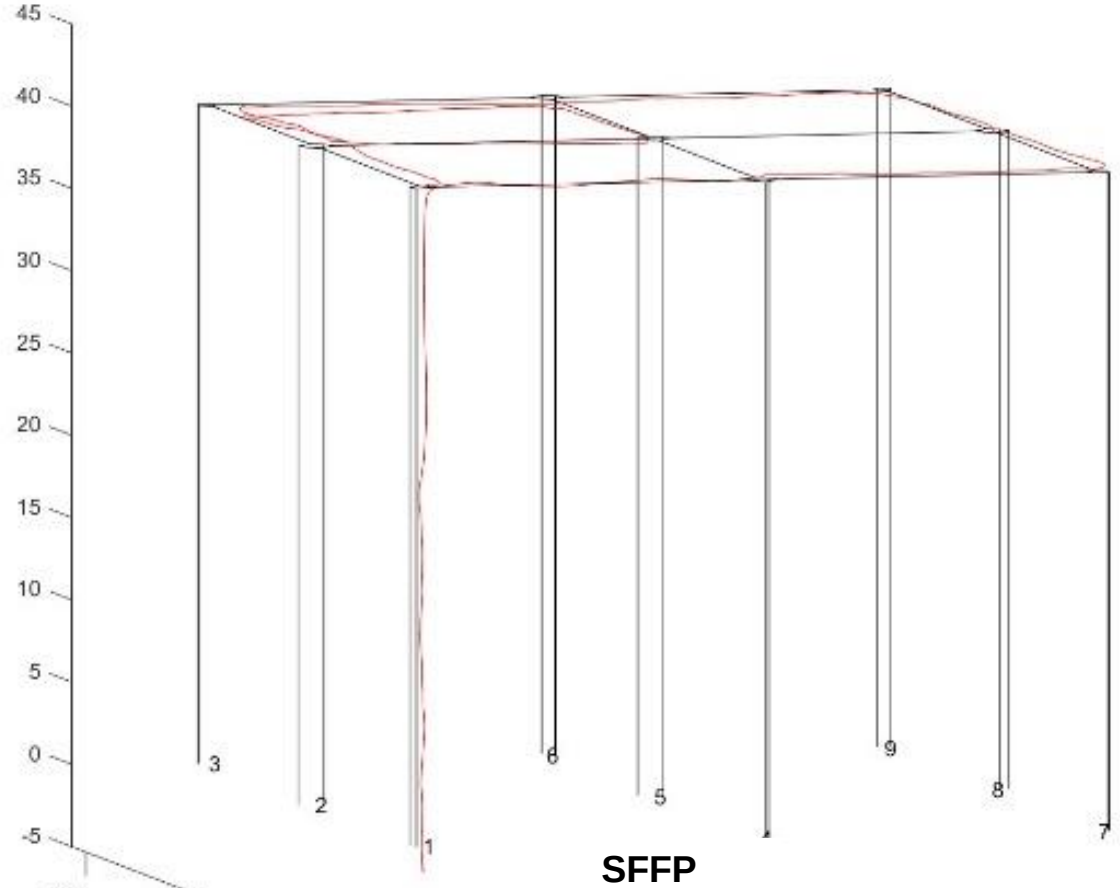
Complex Single UAS Tests: Mission View



At Start of Flight

During First Loop of Flight

Complex Single UAS Tests: Flight Overlay on Lane Network



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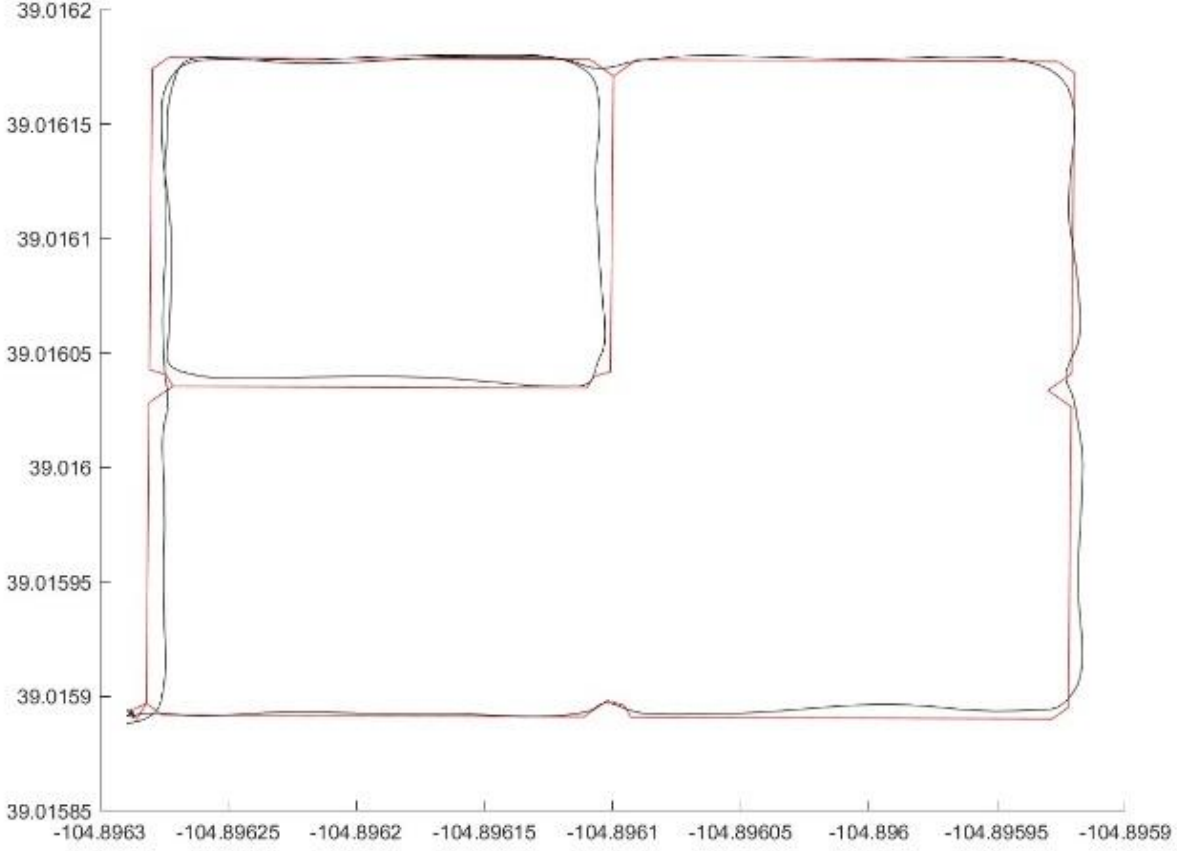
Complex Single UAS Tests: Flight Overlay on Lane Network



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Thank You

Questions?