



UNITED STATES MILITARY ACADEMY
WEST POINT®

Department of Electrical Engineering and Computer Science

From Hulls to Hovering: MOOS-IvP on Multirotor sUAS



USMA Robotics Research Center

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Scott Sideleau (NUWC-NPT), and Michael Novitzky**

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- USMA sUAS Operations
- HAR-V sUAS
- MOOS-IvP integration
- Storm King



Keller Army Community Hospital (KACH) seeks UAS to train its medics for contested logistics

- Summer '25: Alta X for cargo delivery during FTX at Fort Drum and CTC rotation at Fort Johnson (5km BVLOS)

Result: Project MARS

- AY26 Yearlong Cadet Capstone Effort (ME, EE, CS)
- NDAA-compliant, COTS, easily-repairable & modular UAS
- Familiarize Combat Medics (68W) with UAS, conduct daily 2km flights
- Eventual goal of delivering medicine from KACH to Camp Bucker (10 KM one way)
- Full-time NCO working to transition MARS to MEDCOM, T2COM, and other Army sponsors





- Summer 2025: Custom Built 18 SRR-class sUAS
- Rapid prototyping and production of sUAS for ISR
- NDAA Compliant COTS Components
- Reconfigurable Payloads, Field repairable
- ATAK interface for Control (UAS Tool Plug-In)
- Waypoint following missions and teleoperation

**Integrate into SOP
Altitude Deconfliction**

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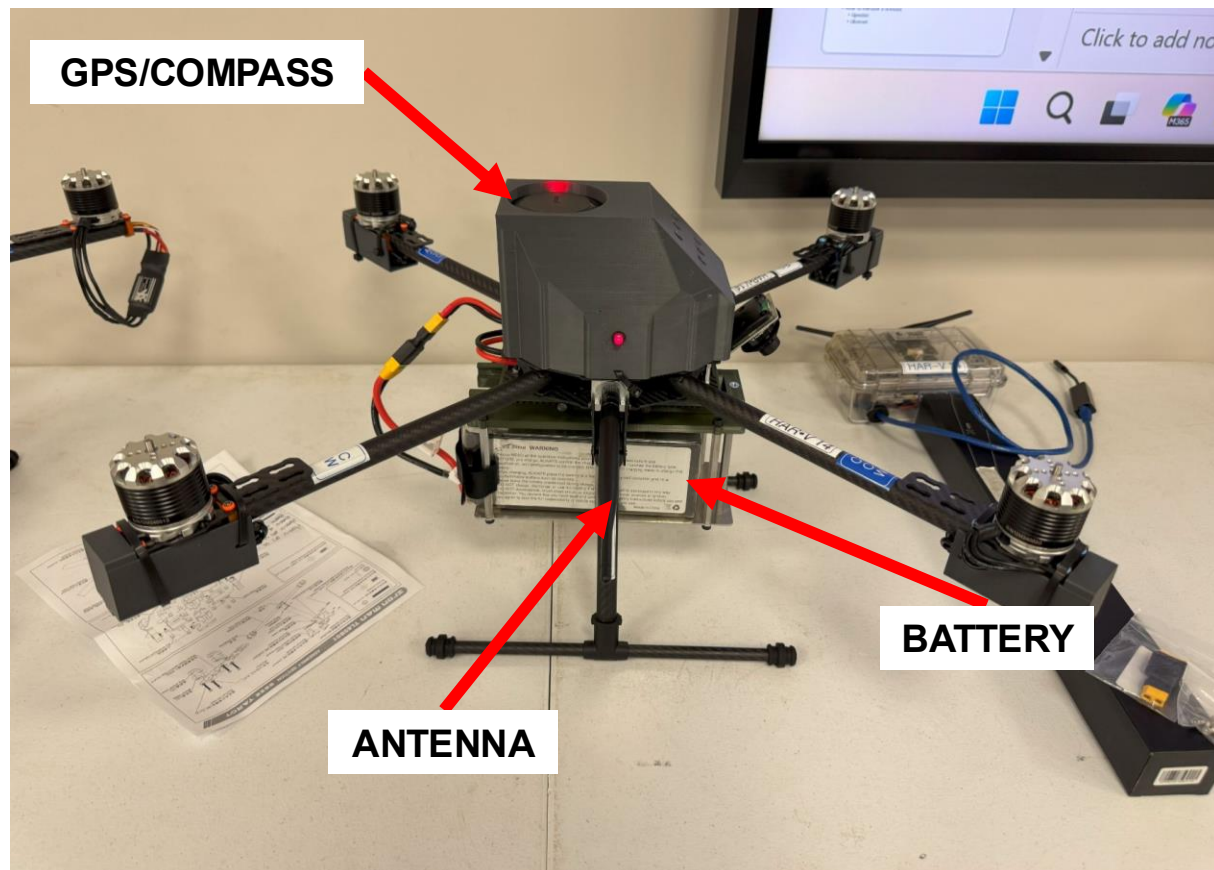




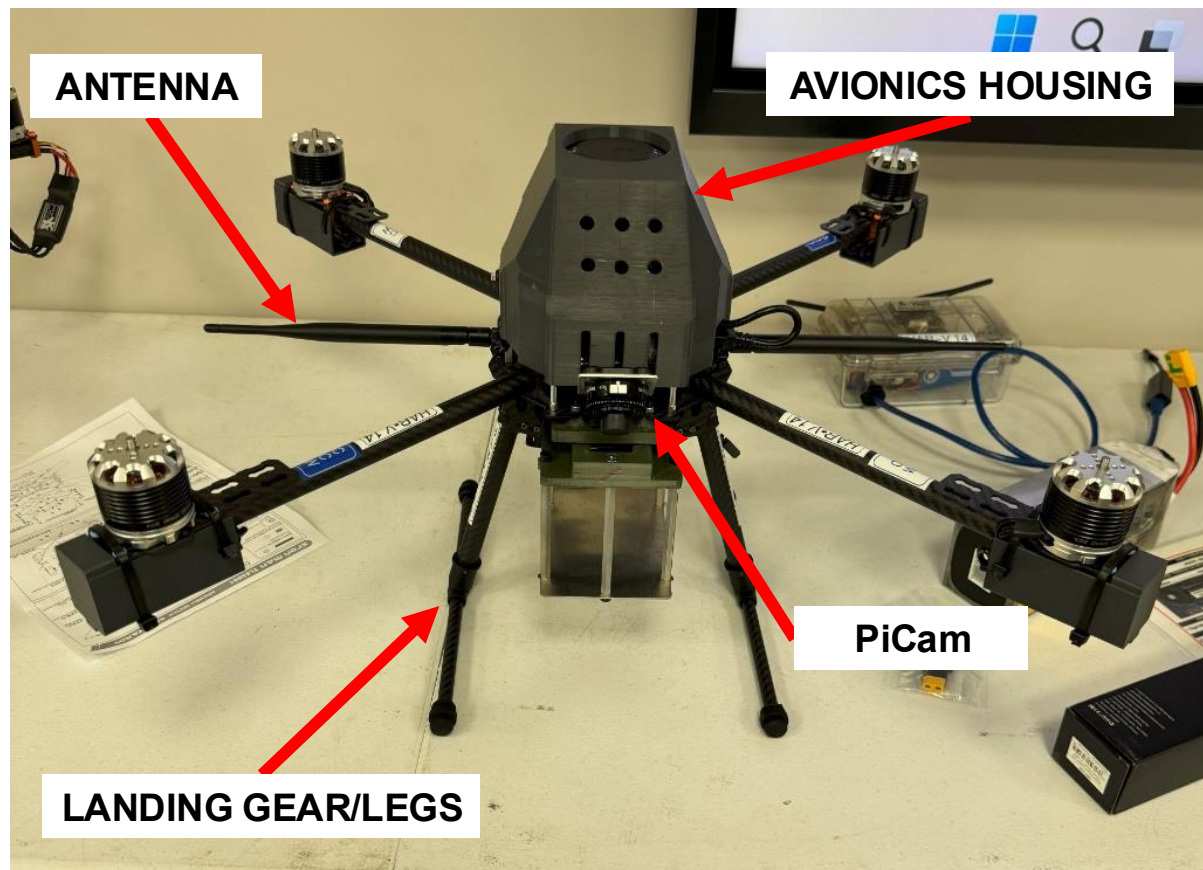
Default sUAS Platform: Harvey

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SIDE VIEW



FRONT VIEW



\$2,650/Harvey. Cube Orange (PX4 firmware, MAVLink protocol) + Pi4B



1:1 Bottleneck

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- No robust control software exists for UAS swarms
 - Would Unlock: COLLABORATIVE Search and Rescue, Package Delivery, Infrastructure Inspection, Pesticide Spraying

Approach: making a swarm-capable autonomy stack work on UAS





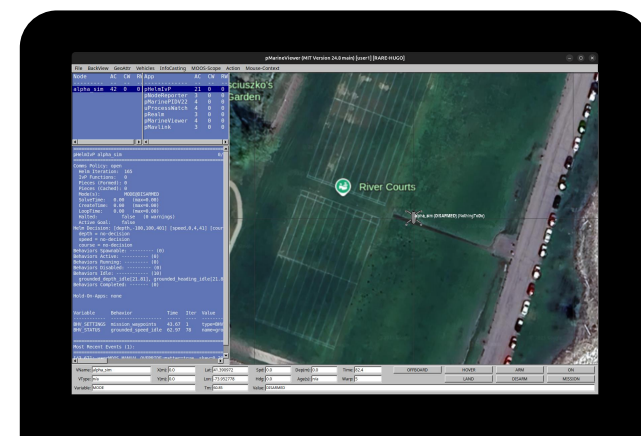
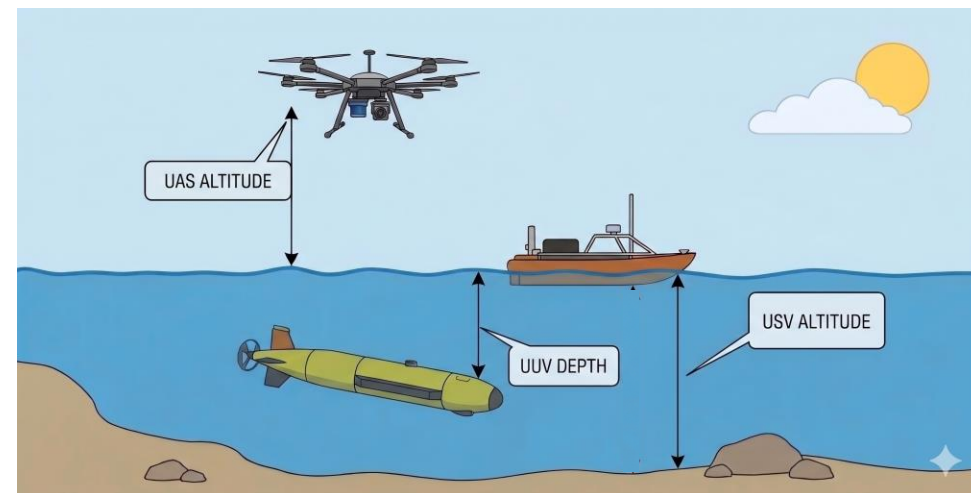
- 2019: Thomas McCabe of Mission Systems LLC built an interface between MOOS-IvP and **PX4** flight controllers
- 2022: Mr. Scott R. Sideleau, SSTM of the Naval Undersea Warfare Center (Newport, RI) developed uSimpleRobot and BHV_SimpleDepth to demonstrate negative depth as a conceptual analog for **altitude above mean sea level (MSL)** for aerial robots and employed its simulations in FVEY S&T AI Strategic Challenge (AISC) experimentation events in Robotic Autonomous Systems (RAS) Transfer of Tactical Control (TOTC)
- 2024: Dr. Dongbin Kim from the University of Hartford improved McCabe's translator to support **MAVLink**

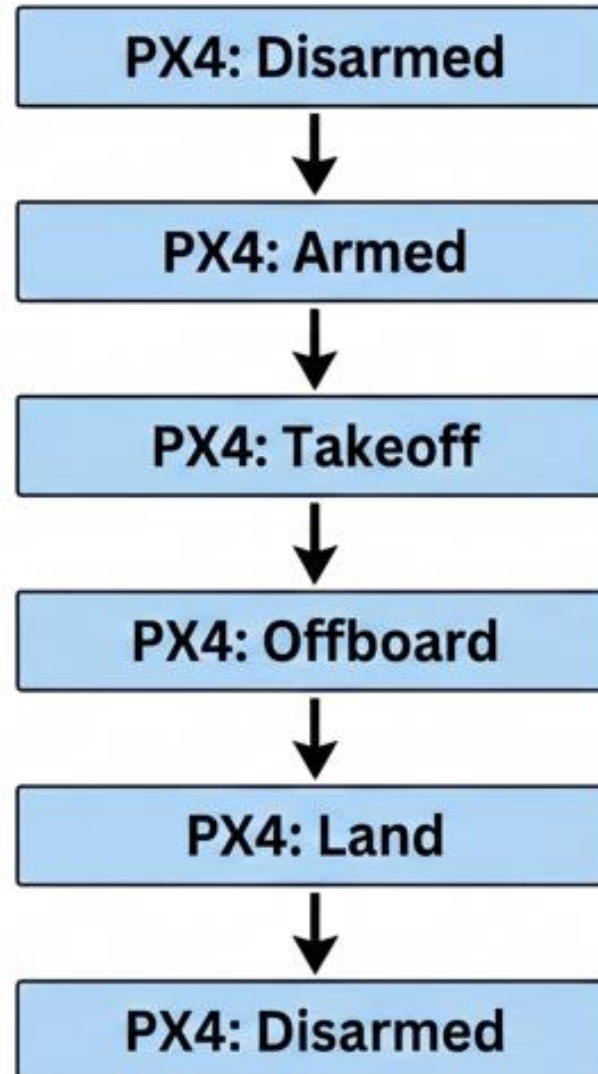


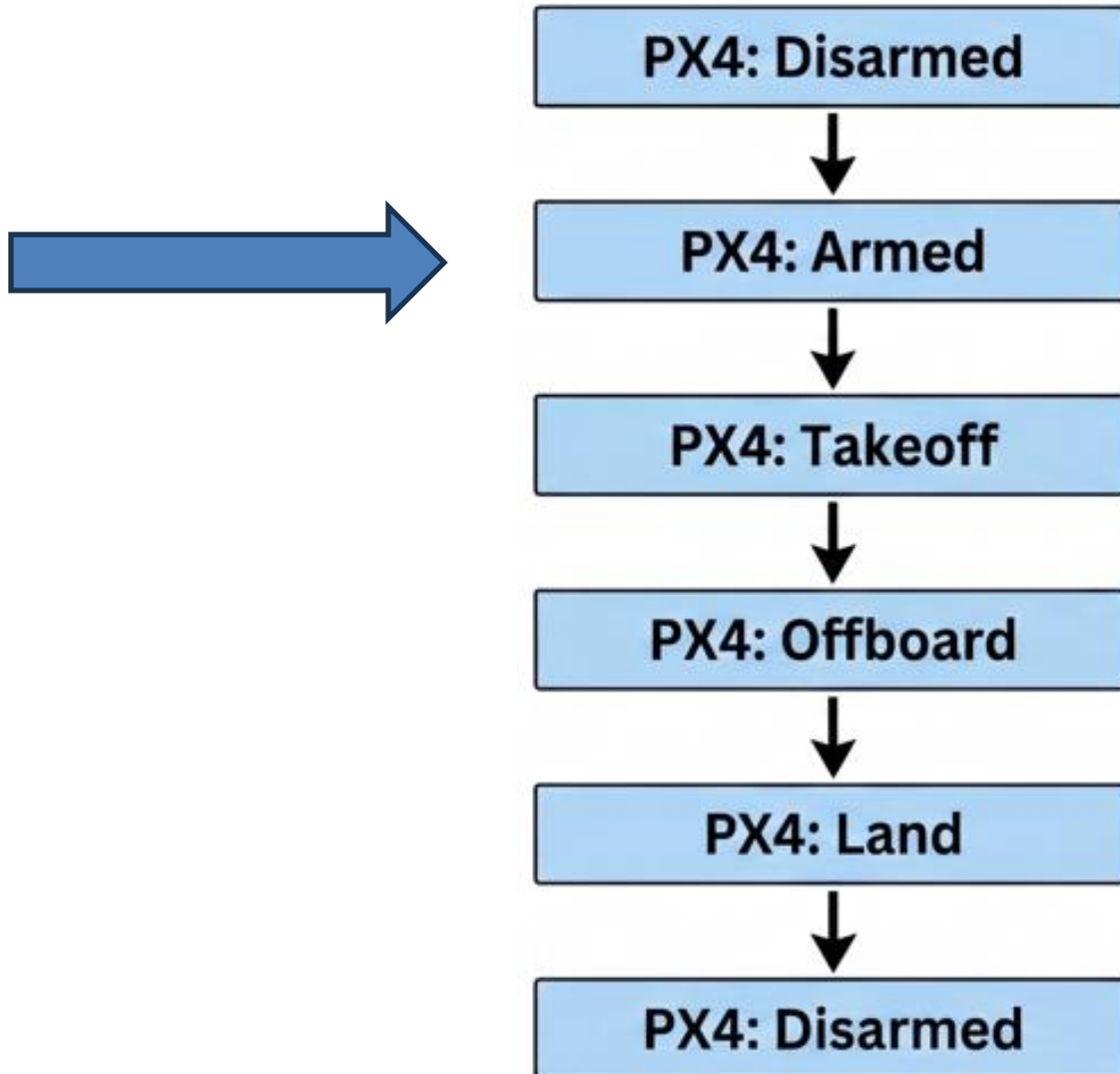


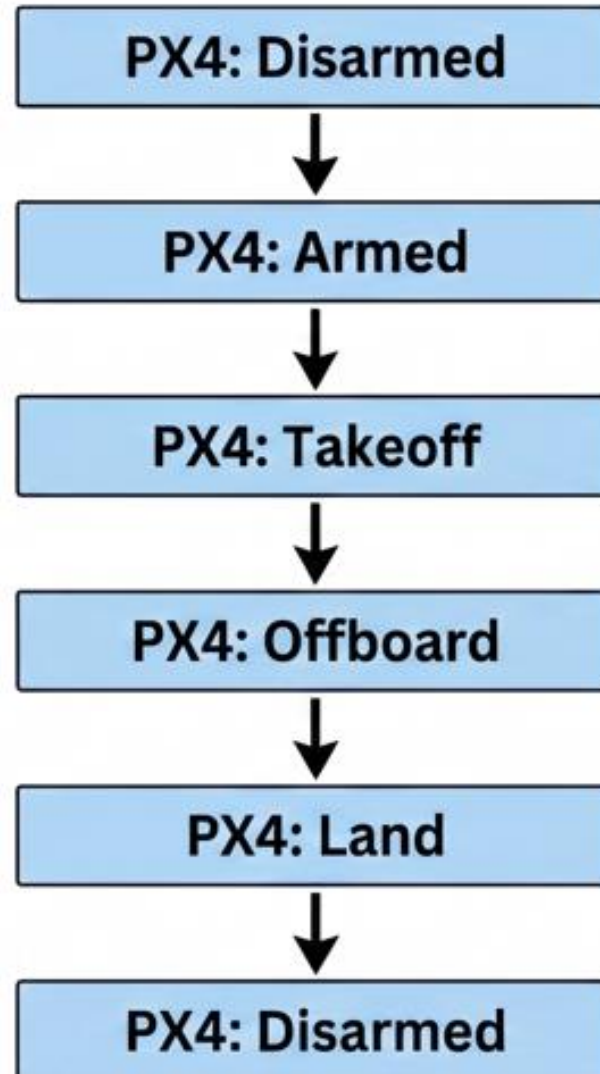
1. Robust Ground Control Interface which can also serve as a simulation environment

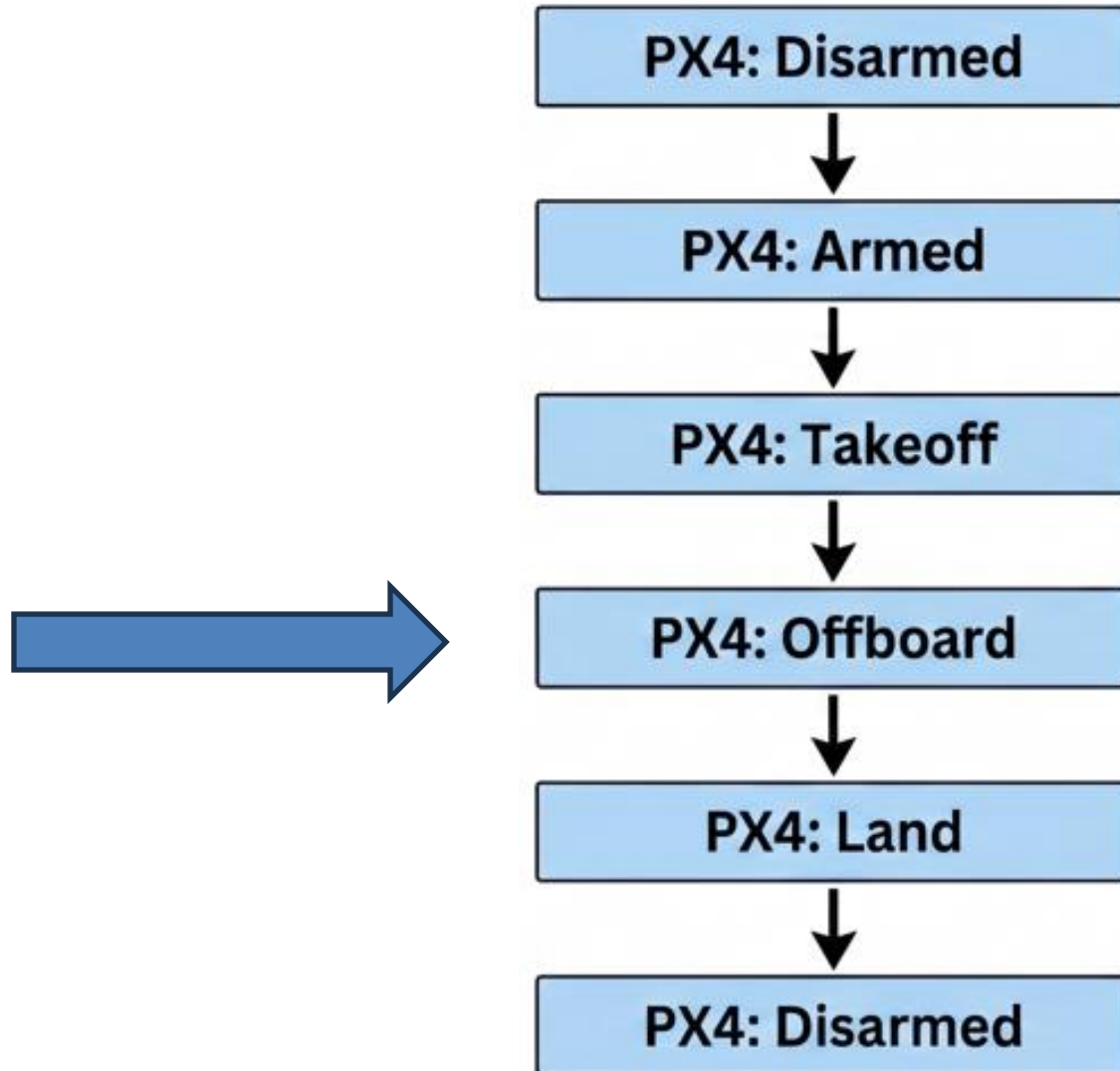
1. Standardize dual-definition variables such as “altitude”
2. Align state sequence with that of PX4-controlled UAS
3. Customize GUI with relevant command buttons
4. Map change and UAS sprite to match desired testing conditions

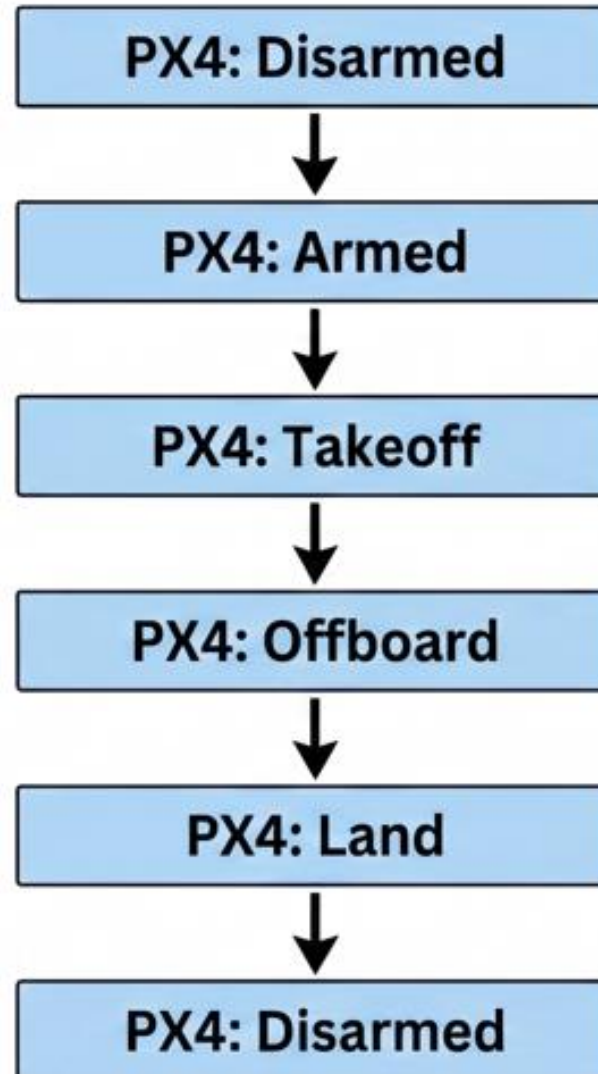


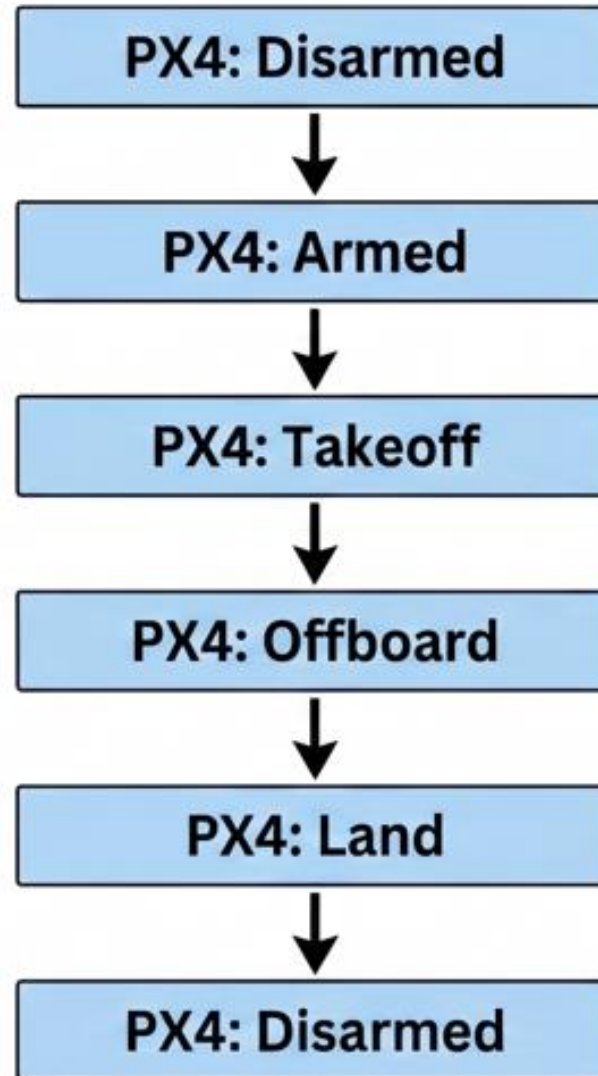


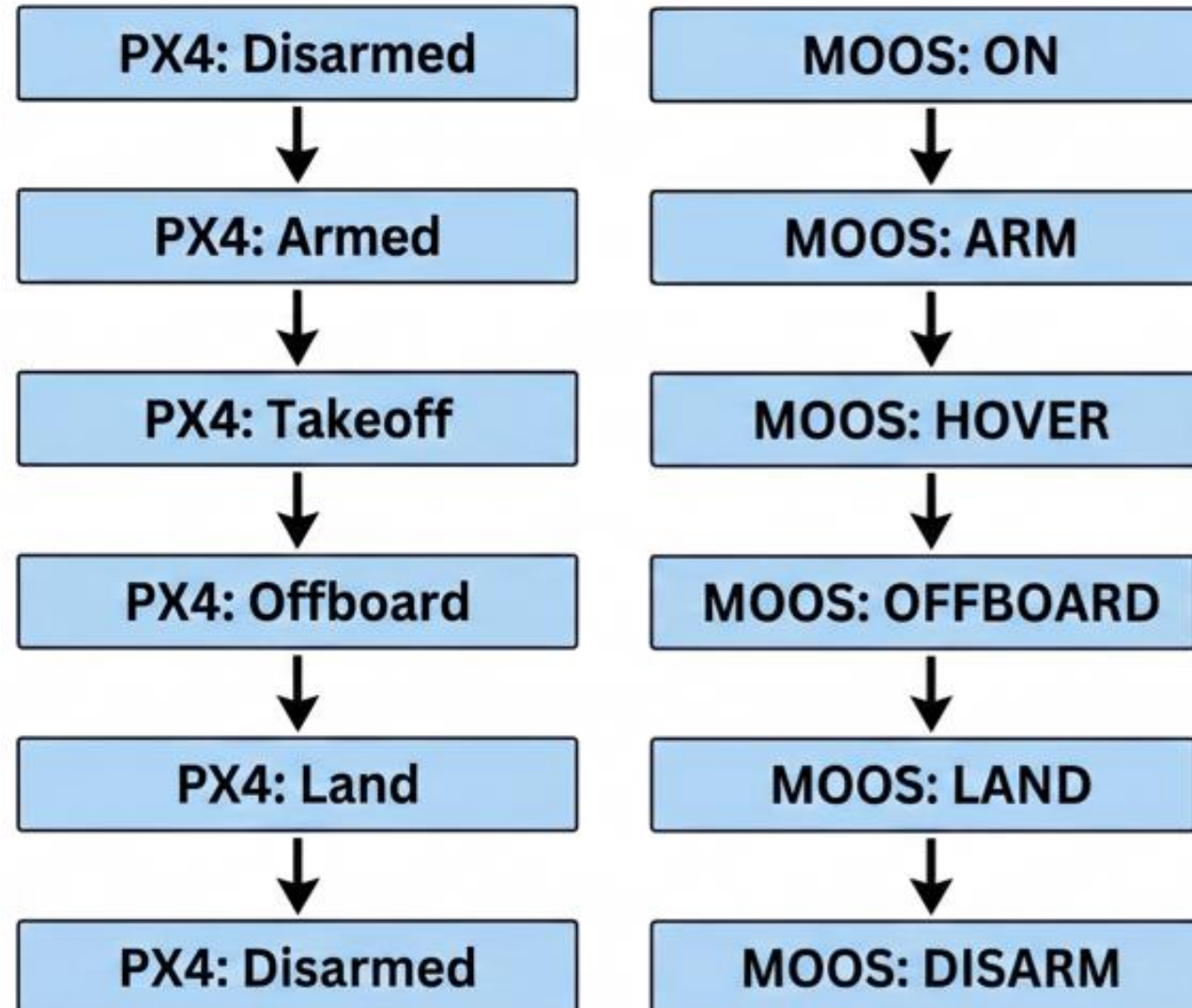












File BackView GeoAttr Vehicles InfoCasting MOOS-Scope Action Mouse-Context

Node	AC	CW	RW	App	AC	CW	RW
alpha_sim	42	0	0	pHelmIvP	21	0	0
				pNodeReporter	3	0	0
				pMarinePIDV22	4	0	0
				uProcessWatch	4	0	0
				pRealm	3	0	0
				pMarineViewer	4	0	0
				pMavlink	3	0	0

pHelmIvP alpha_sim 0/

Comms Policy: open

Helm Iteration: 165

IvP Functions: 0

Pieces (Formed): 0

Pieces (Cached): 0

Mode(s): MODE@DISARMED

SolveTime: 0.00 (max=0.00)

CreateTime: 0.00 (max=0.00)

LoopTime: 0.00 (max=0.00)

Halted: false (0 warnings)

Active Goal: false

Helm Decision: [depth,-100,100,401] [speed,0,4,41] [cour

depth = no-decision

speed = no-decision

course = no-decision

Behaviors Spawnable: ----- (0)

Behaviors Active: ----- (0)

Behaviors Running: ----- (0)

Behaviors Disabled: ----- (0)

Behaviors Idle: ----- (10)

grounded_depth_idle[21.81], grounded_heading_idle[21.8

Behaviors Completed: ----- (0)

Hold-On-Apps: none

Variable

BHV SETT

BHV_STATU

Most Rece

[13.671: var=MOOS-MANUAL-OVERRIDE-matter=true

VName: alpha_sim

X(m): 0.0

Lat: 41.390972

Spd: 0.0

Dep(m): 0.0

Time: 0.0

ON BOARD

HOVER

ARM

ON

VType: n/a

Y(m): 0.0

Lon: -73.952778

Hdg: 0.0

Age(s): n/a

Warp: 5

LAND

DISARM

MISSION

Variable: MODE

Tm: 60.85

Value: DISARMED

sciuszko's
Garden

River Courts

alpha_sim (DISARMED) (NothingToDo)

PX4: Disarmed

MOOS: ON

PX4: Armed

MOOS: ARM

PX4: Takeoff

MOOS: HOVER

PX4: Offboard

MOOS: OFFBOARD

PX4: Land

MOOS: LAND

PX4: Disarmed

MOOS: DISARM

OFFBOARD

HOVER

ARM

ON

LAND

DISARM

MISSION

File BackView GeoAttr Vehicles InfoCasting MOOS-Scope Action Mouse-Context

Node	AC	CW	RW	App	AC	CW	RW
alpha_sim	70	0	0	pHelmIvP	11	0	0
				pNodeReporter	8	0	0
				pMarinePIDV22	17	0	0
				uProcessWatch	9	0	0
				pRealm	7	0	0
				pMarineViewer	10	0	0
				pMavlink	8	0	0

pMarinePIDV22 alpha_sim 0/0(165)

Frequency:19.954

Speed Factor: 0

PID has control: false

PID override: true

PID stale: true

PID Settings:

Thrust Cap Enabled: false

Thrust Cap: 100.00000

YAW_PID_KP = 0.9

YAW_PID_KD = 0.3

YAW_PID_KI = 0.3

YAW_PID_INTEGRAL_LIMIT = 0.07

Max rudder: 100

SPEED_PID_KP = 2

SPEED_PID_KD = 2

SPEED_PID_KI = 0.25

SPEED_PID_INTEGRAL_LIMIT = 0.07

Max thrust: 100

PITCH_PID_KP = 0

PITCH_PID_KD = 0

PITCH_PID_KI = 0

PITCH_PID_INTEGRAL_LIMIT = 0

Max pitch: 15

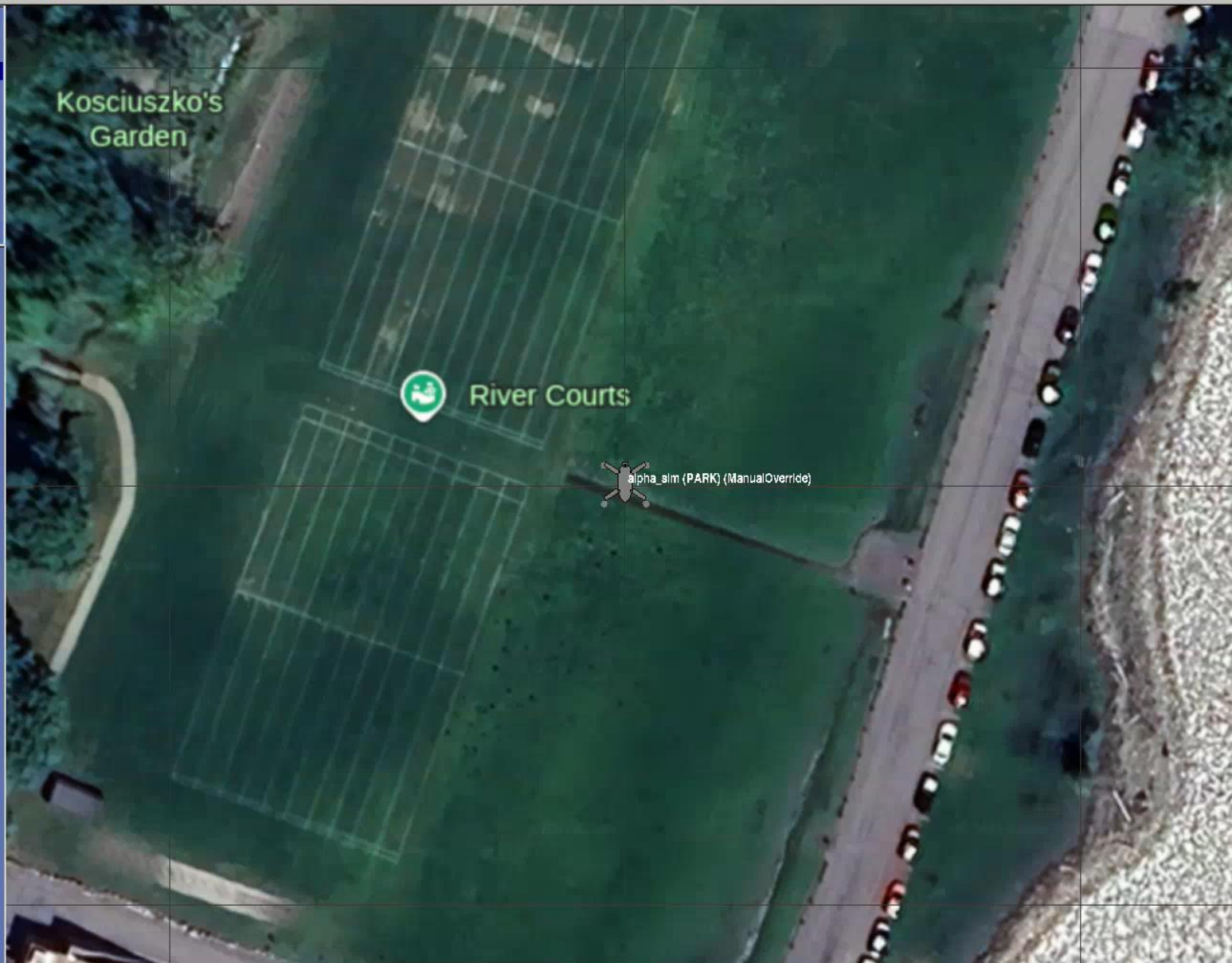
Z_TO_PITCH_PID_KP = 0

Z_TO_PITCH_PID_KD = 0

Z_TO_PITCH_PID_KI = 0

Z_TO_PITCH_PID_INTEGRAL_LIMIT = 0

Max elevator: 13



VName: alpha_sim

X(m): 0.0

Lat: 41.390972

Spd: 0.0

Dep(m): 0.0

Time: 7.5

OFFBOARD

HOVER

ARM

ON

VType: n/a

Y(m): 0.0

Lon: -73.952778

Hdg: 0.0

Age(s): n/a

Warp: 1

LAND

DISARM

MISSION

Variable: MODE

Tm: -0.27

Value: DISARMED





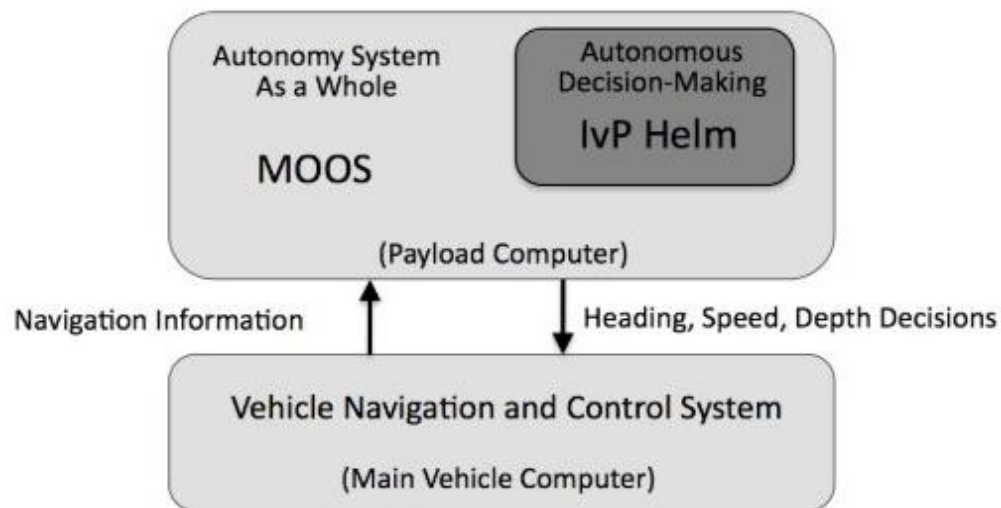
- Support cadet summer training (CST)
- Summer 2026: Custom Built 18 SRR-class sUAS
- Rapid prototyping and production of sUAS for ISR
- NDAA Compliant COTS Components
- IP54 Environmental Rating
- Reconfigurable Payloads
- Field repairable
- ATAK interface for Control (UAS Tool Plug-In)
- Waypoint following missions and teleoperation
- Video streaming and object detection on ATAK
- 250 mm frame with 9" propellers
- 20 minutes endurance
- Raspberry Pi 5
- ~\$2.6K in components
- EO/IR



Research
Drone Manufacturing and Development
Training



Verification and Validation of GenAI produced Missions



Successful in the Naval Domain



RRC is implementing MOOS-IvP
onboard UAS



Accessible: Operators use natural language instructions to describe desired behaviors

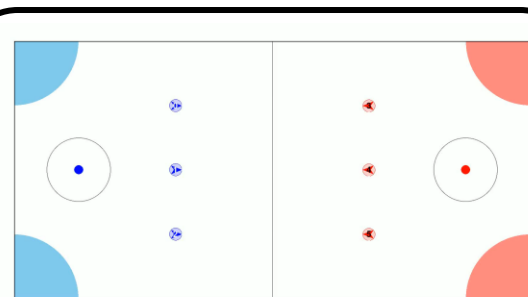
Interpretation: A large language model (LLM) produces MOOS-IvP mission files

V&V: Is the mission executable and does it perform as requested

Sim and Real: Those LLM created missions validated in simulation are then run on real robots



Training

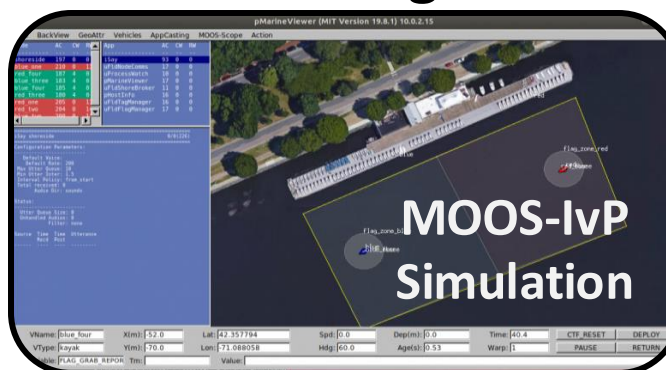


Pyquaticus Gymnasium



Policies

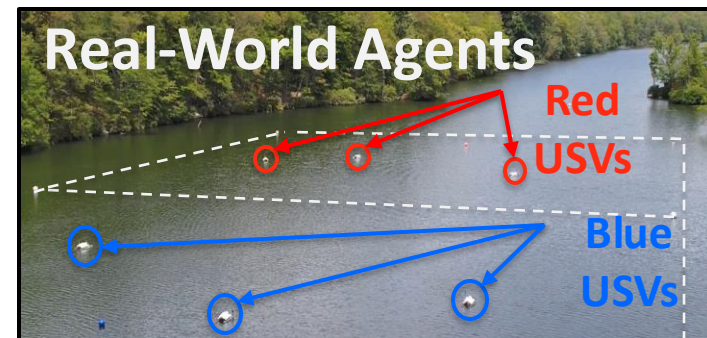
Testing



**MOOS-IvP
Simulation**

**Pyquaticus-MOOS
Bridge**

Deployment



Real-World Agents

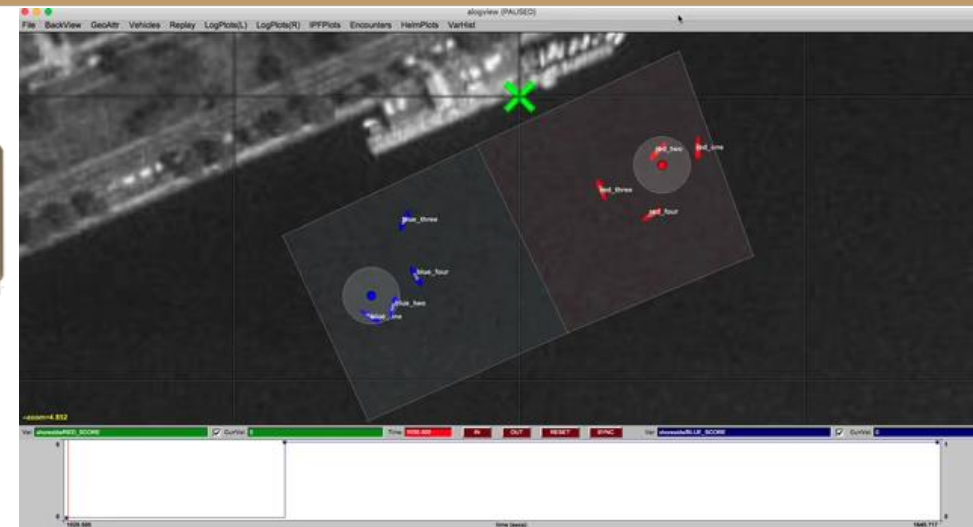
**Red
USVs**

**Blue
USVs**

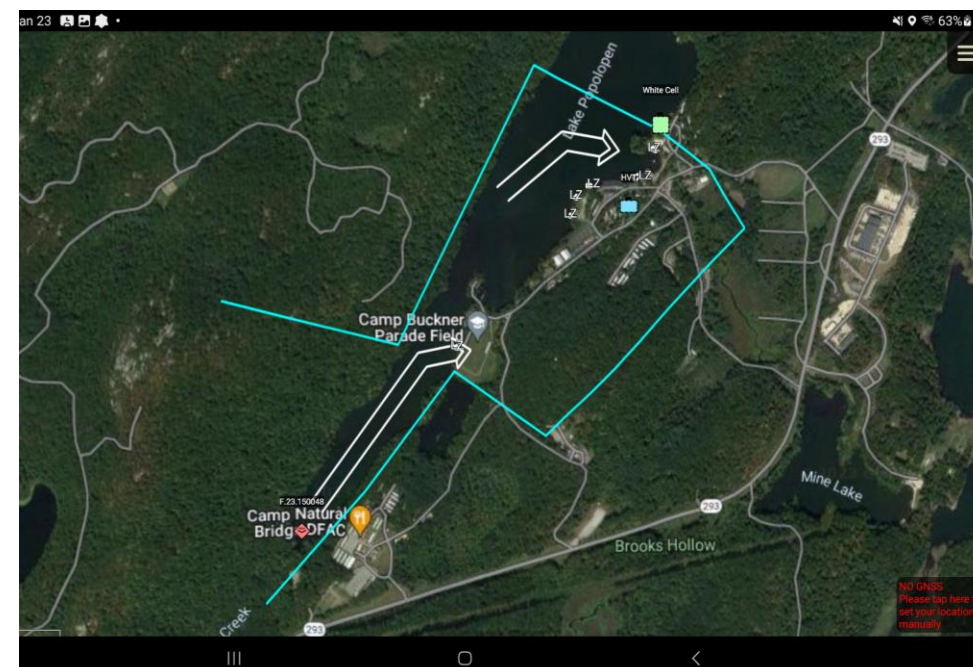
MOOS-IvP Middleware

- Pyquaticus is a lightweight Python MCTF simulator with a multi-agent Gymnasium API that is compatible with reinforcement learning libraries
- Pyquaticus-MOOS Bridge uses PyMOOS to handle communication between policies running in Python and MOOS-IvP middleware

Maritime Capture the Flag Competition 2026, Kliem¹, Prithviraj Dasgupta¹, Peter Crowley-Dolen², Matthew Cleaveland², Brendan Long², Michael Novitzky³, Audrey Aldridge³, Tyler Errico³, AAMAS 2026 Competition. U.S. Naval Research Laboratory¹ Massachusetts Institute of Technology – Lincoln Laboratory (MIT-LL)² United States Military Academy (USMA)³



- Hosting at West Point in 17-28-AUG
- Sponsored by OUSW-RE
- ~100 researchers from FVEYs nations to attend
- ~100 Soldiers/Cadets for offensive vs defensive
- Scenario is an Urban-Littoral Assault onto beach near Barth Hall to secure HVT
- Both teams heavily augmented with 23 merging FVEY technologies including swarms of unmanned systems





QUESTIONS?