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MOOS-IvP Lessons with COLREGs, Kayaks, UAVs, and Windows

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**MOOS Development and Applications Working Group
Cambridge, MA, August 24-25, 2010**

Overview



- **About SARA**
- **The SARA Boat Lab**
 - Current and future vessels
 - Lessons Learned: Hardware and Logistics
- **How we use MOOS**
 - General Implementation
 - Custom MOOS apps
- **Simulating UAVs**



SARA, Inc.



*"The special projects division of a Major Defense Contractor ...
...Without the Major Defense Contractor"*

**Alternative
Energy**



Advanced RF



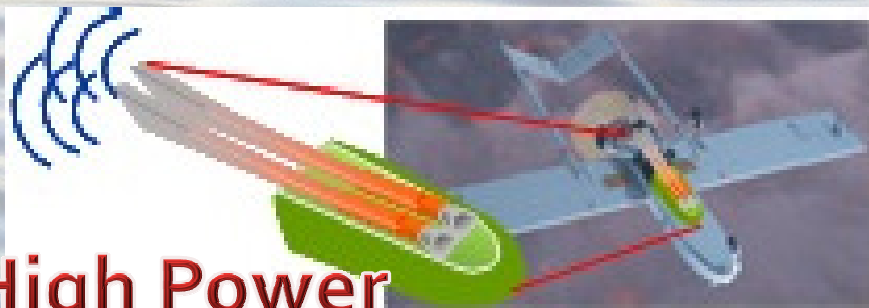
**High Power
Microwave**



**EMP
Hardening**



**High Power
Acoustics**



**Ground
Robotics**



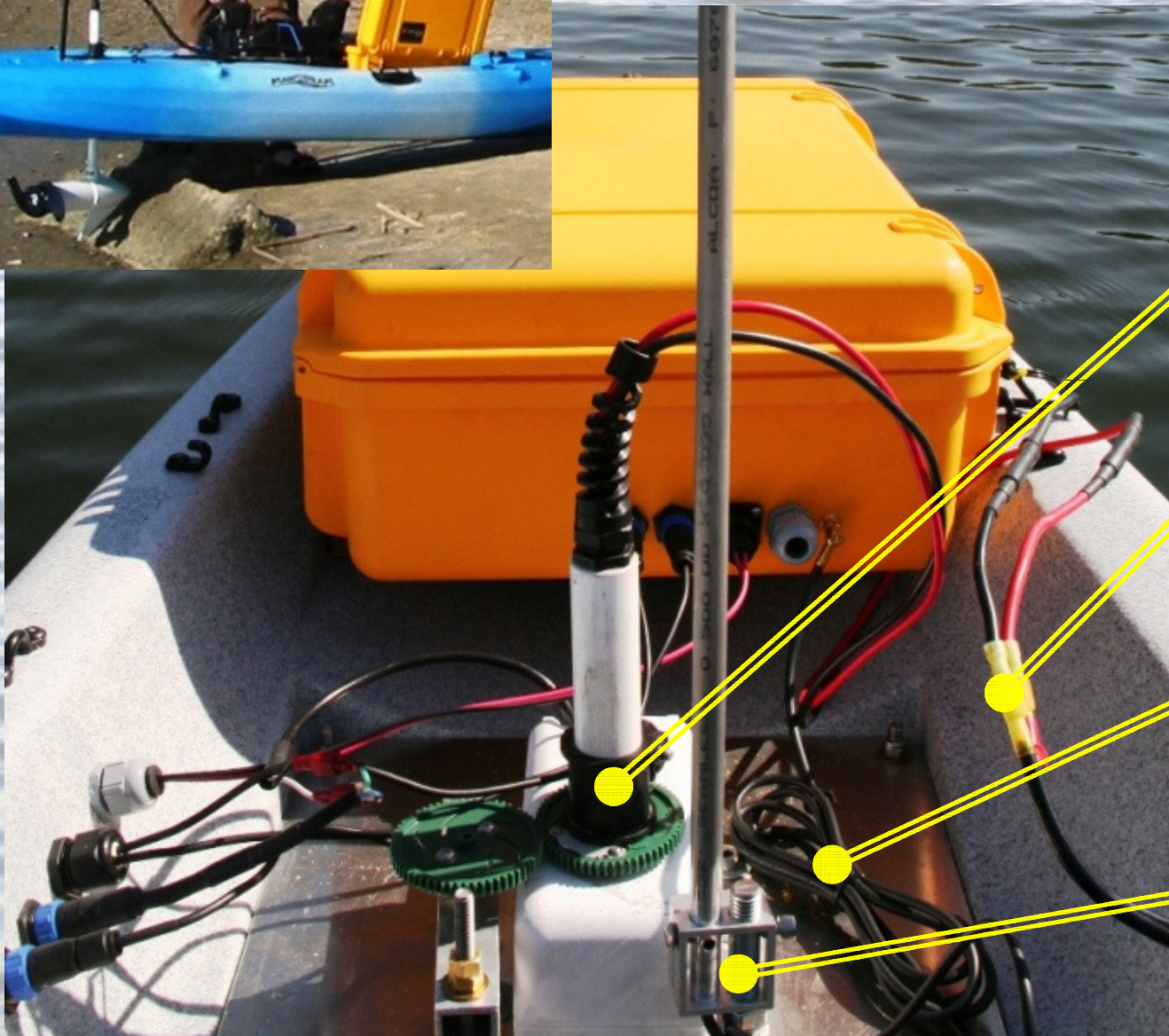
SARA Boat Lab Overview



- Top speed 5kts (1.5m/s)
- Battery life 2 - 4hrs
- Sensors GPS, compass
- Allows for payload and/or passengers



Boat Lab Lessons Learned



**Separate drive
and PC power**

Steering sensor

**High current
connectors**

Clean deck

**Breakaway
antenna mount**

Rejected Logistics



Transportation / Logistics

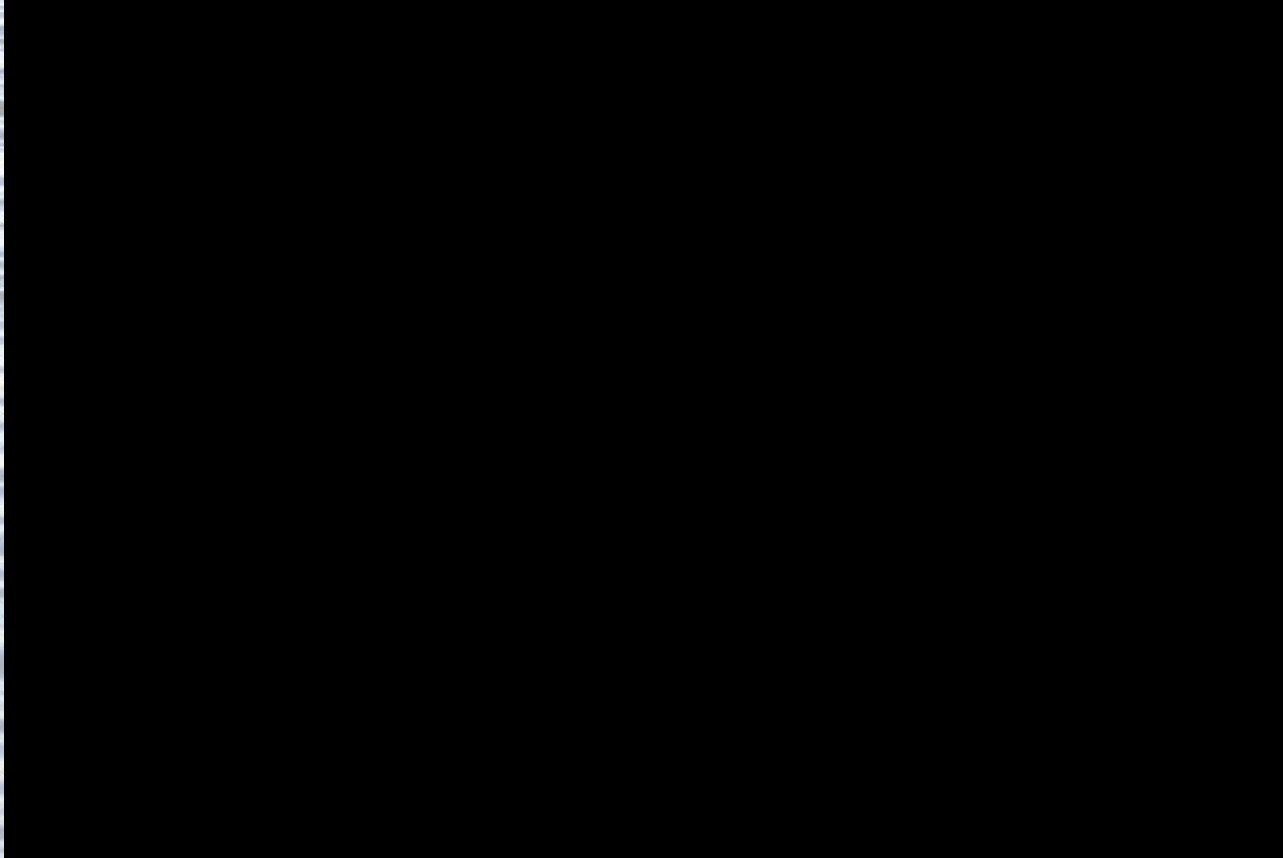


Boat Lab Next Steps

- Oceanscience Q-Boat
- Commercial product for bathymetry and river flow measurements
- Existing pilot through hobby remote control
- Now running MOOS



Boat Lab Next Steps



SBIR RIGHTS Deploying with MOOS



pMarineViewer

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

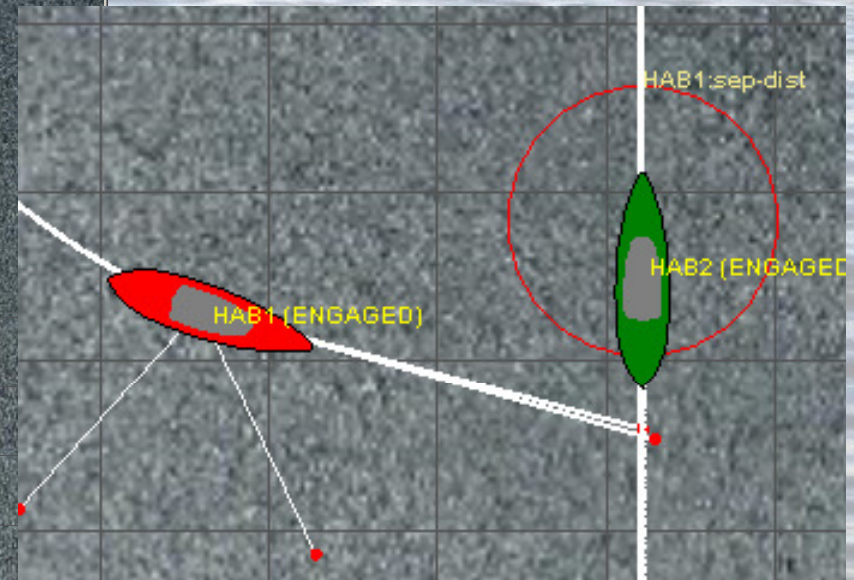
VName: HAB1 X (m): 316.3 Lat: 34.088146 Spd (m/s): 1.4 Time: 247.1
 Rpt-Age: 0.45 Y (m): 507.2 Long: -117.808817 Heading: 108.5 Warp: 1

Variable	Time	Value	Range	Bearing
STAGE_HAB1	47.63	Station_Pt=110,590	597.7	31.94

Scenes: N 0 5, 1 6, 2 7, 3 8, 4 9

HAB1: Avoid , Cross , HeadO , OverT
 HAB2: Avoid , Cross , HeadO , OverT

IDLE, STAGE, DEPLOY, GOHERE



34.088146 Spd (m/s): 1.4 Time: 247.1

-117.808817 Heading: 108.5 Warp: 1

Value Range Bearing

_Pt=110,590 597.7 31.94

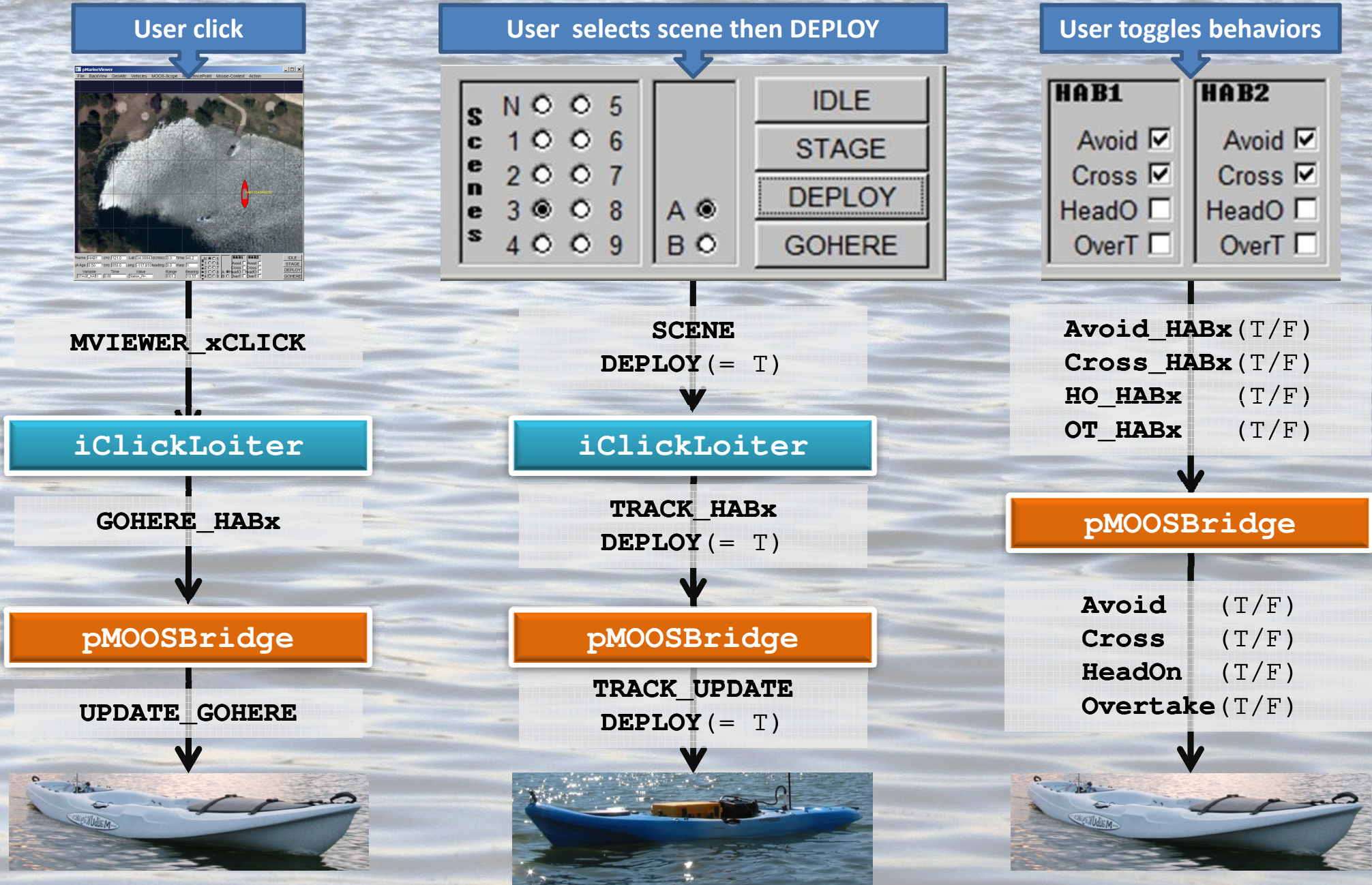
Scenes: N 0 5, 1 6, 2 7, 3 8, 4 9

A B

HAB1: Avoid , Cross , HeadO , OverT
 HAB2: Avoid , Cross , HeadO , OverT

IDLE, STAGE, DEPLOY, GOHERE

SBIR RIGHTS Deployment Strategy



Deploying with MOOS

Vessels

	Simulation	Actual
Community:	SIMHABx	HABx
ServerHost:	localhost	192.168.1.(10+x)
ServerPort:	9000	(9000 + x)
Applications:	MOOSDB pMarinePID pNodeReporter pHelmlvP pLogger iMarineSim	MOOSDB pMarinePID pNodeReporter pHelmlvP pLogger
	iRoboteq	iRoboteq
	iOSWin	iOSWin
	iGarWin	iGarWin
	iClickLoiter	iClickLoiter
		pCompass
		pRM



Shore Station

	Simulation	Actual
Community:	SIMSHORE	SHORE
ServerHost:	localhost	192.168.11.2
ServerPort:	9000	9000
Applications:	MOOSDB pMOOSBridge pMarineViewer	MOOSDB pMOOSBridge pMarineViewer
	iClickLoiter	iClickLoiter
	pSARAViewer	pSARAViewer

Custom MOOS Applications



- **iRoboteq** Steering, drive motor, indicator light, reports battery, current, e-stop, etc.
- **iOSWin** Interface to OS5000 digital compass
- **iGarWin** Interface to Garmin 18x and 18x-USB



Custom MOOS Applications



- pMOOSLodg **Manages pseudo-cooperative vehicles**

The screenshot displays the pSARAVIEWER application window, which is a multi-panel interface for managing pseudo-cooperative vehicles. The interface is organized into six vertical columns, each representing a different vehicle or scenario. The first column is labeled 'ALL' and contains a 'Scenarios' section with a grid of radio buttons (1-9) and a set of checkboxes for 'AVOID', 'CROSS', 'HEAD ON', and 'OVERTAKE'. Below this are buttons for 'IDLE', 'PAUSE', 'LOITER NOW', 'GO HERE', 'STAGE', and 'DEPLOY'. The remaining five columns are labeled 'TBD1' through 'TBD5'. Each of these columns has a 'No Connection' status bar at the top, followed by input fields for 'Rel. Range' and 'Rel. Bearing'. Below these are radar displays showing a heading of 000 degrees and a speed of 0.0 m/s. Each radar display is accompanied by a vertical scale bar with a '2.00' marker. At the bottom of each TBD column is a 'Role' section with five radio buttons (1-5) and a set of checkboxes for 'AVOID', 'CROSS', 'HEAD ON', and 'OVERTAKE'. Below the checkboxes are buttons for 'IDLE', 'PAUSE', 'LOITER NOW', 'GO HERE', 'STAGE', and 'DEPLOY'. The 'IDLE' button in the 'ALL' column is highlighted in green.

Custom MOOS Applications



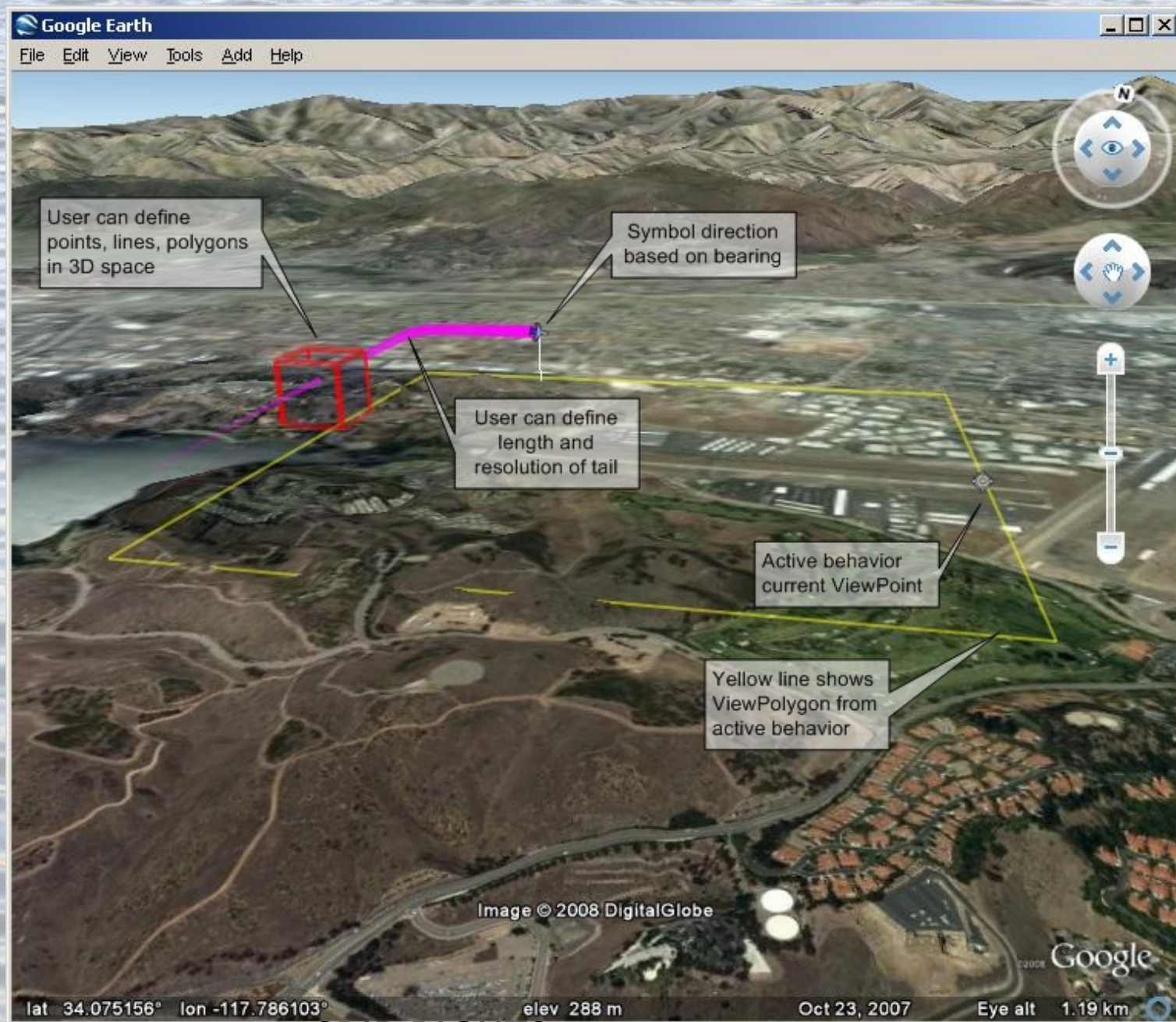
- **pCompass** Solves GPS-compass heading handoff
 - Low-cost digital compass requires regular calibration
 - GPS only accurate above $\sim 0.8\text{m/s}$
 - Vehicle reduces velocity on turns
- **Without pCompass:**
 - iGarWin subscribed to COMPASS_HEADING
 - iGarWin published NAV_HEADING based on speed
 - Problem: Yo-yo heading response
- **pCompass provides:**
 - low-pass filter
 - speed-based weighting

= smooth the sensor heading shift

SBIR RIGHTS Custom MOOS Applications



- pGE

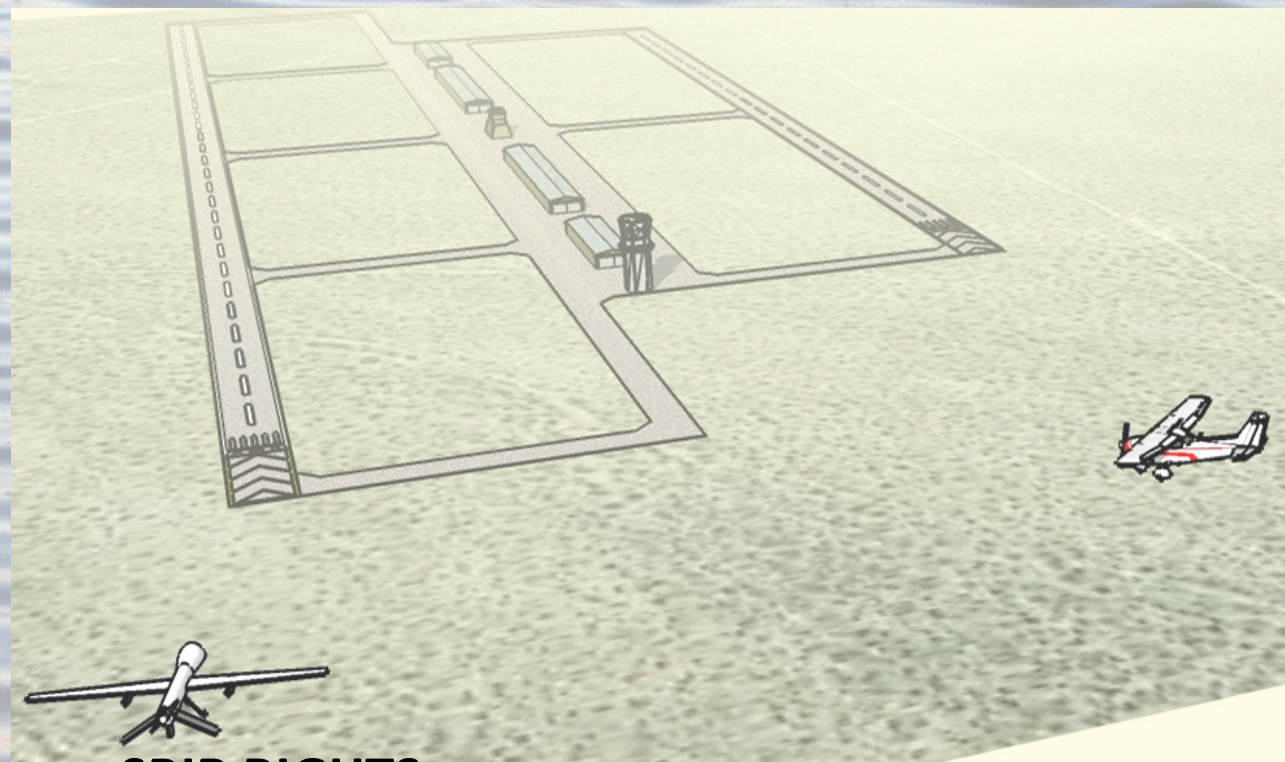
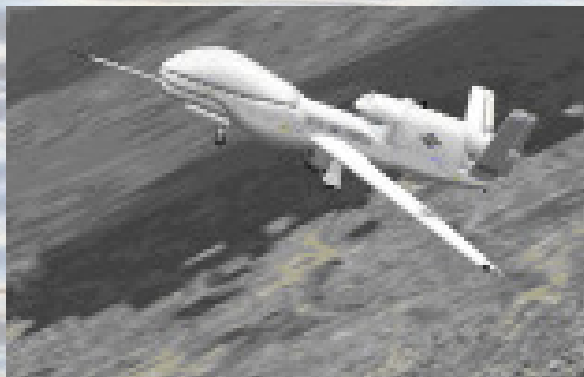
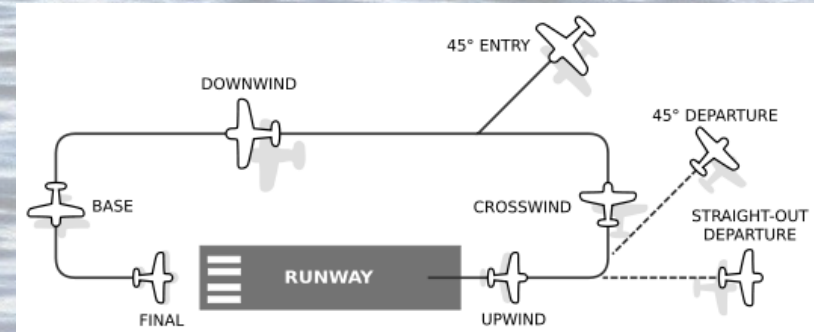


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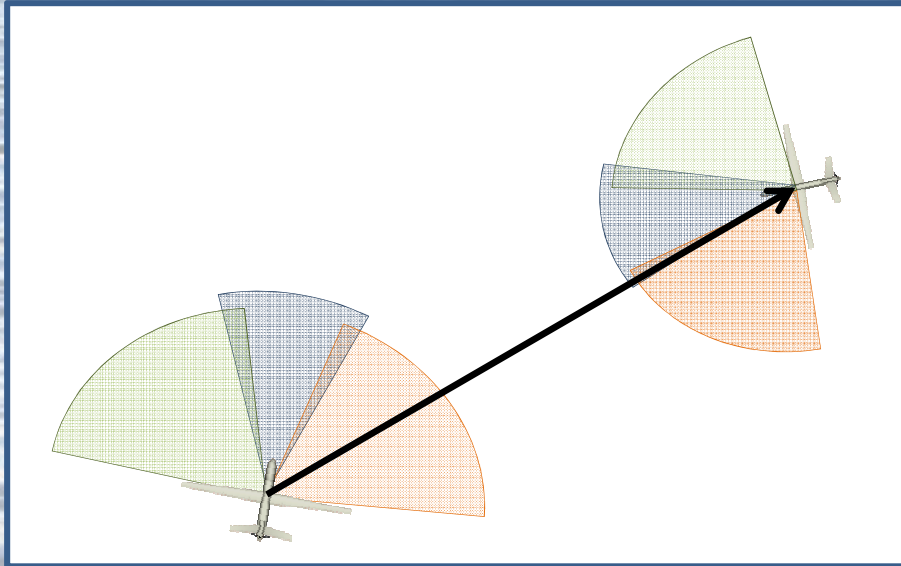
UAV Simulation with MOOS



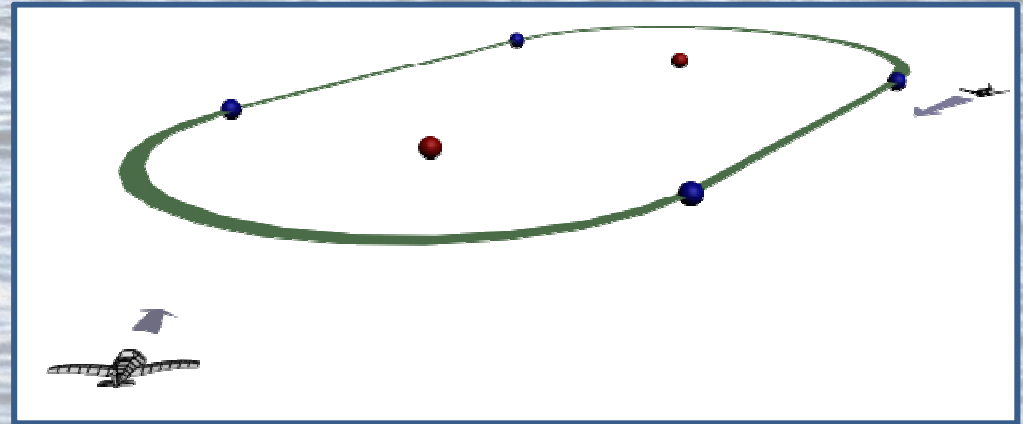
- **Deconfliction in the TAO**
 - **Air Traffic Control (ATC) Directives**
 - **Mission Objective**
 - **Collision Avoidance**
 - **Rules of the Road**
 - **Restricted Areas**
 - **Terrain Avoidance**



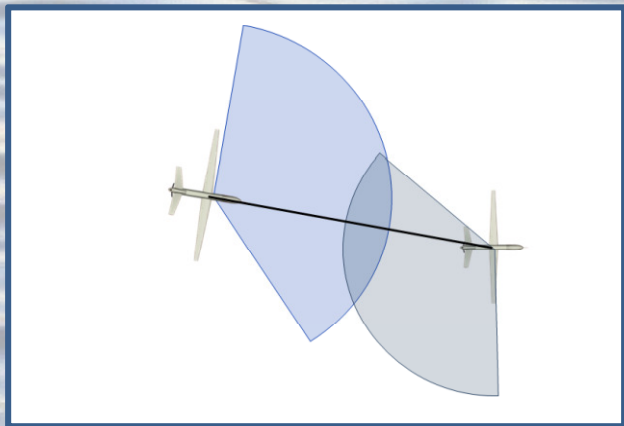
UAV Simulation with MOOS



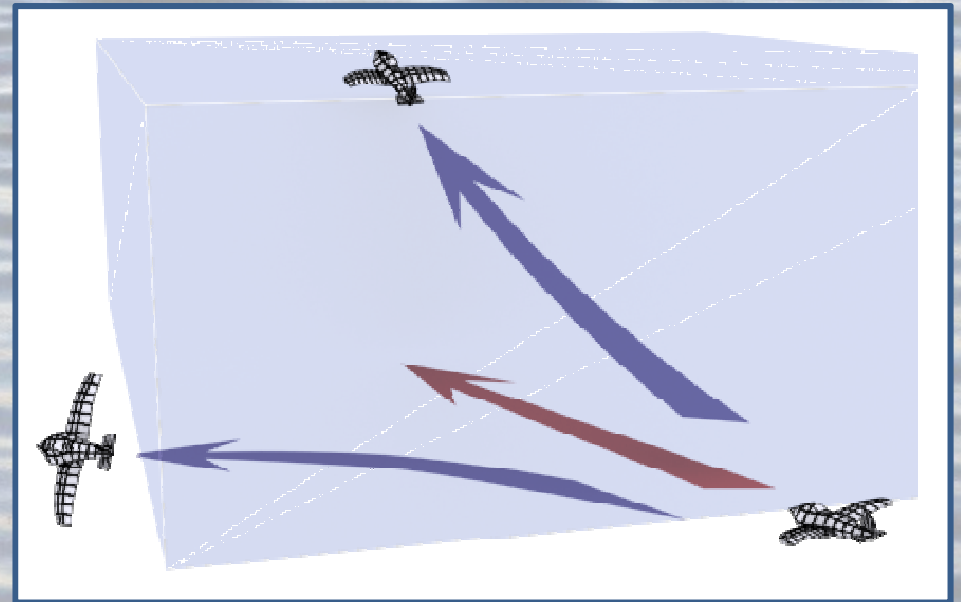
BHV_CoAltTraffic



BHV_HoldingPattern

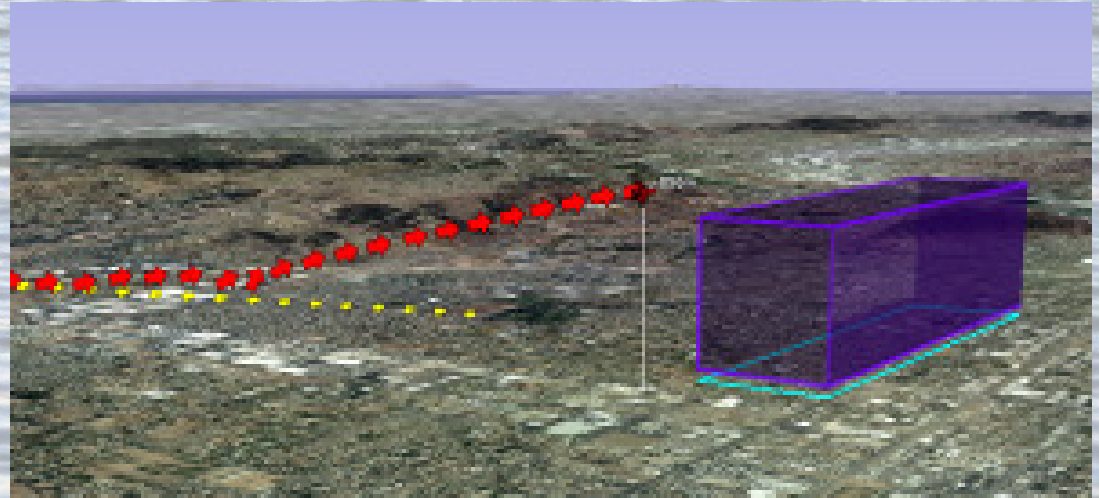


BHV_CoAltOvertake



BHV_AvoidAirspace

UAV Simulation with MOOS



Acknowledgements

- Los Angeles County Lifeguards
- ONR
- Mike Benjamin
- SARA Boat Lab volunteers

