MOOS External Interface

& TAK Autonomy Integration

Michael DeFilippo | Supun Randeni
MIT AUV Laboratory | Marine Autonomy Laboratory

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moos-ivp-tak · pTAKBridge · MEI

Talk Overview

PART 1

MOOS External Interface (MEI)

› What is MEI and why it exists

› High-level architecture

› protobuf_client · iMOOSGateway

› iMOOSClient · iMavlinkBridge

› ROS 2 ↔ MOOS-IvP bridge use case

PART 2

pTAKBridge & TAK Integration

› TAK ecosystem overview

› MOOS-IvP ↔ CoT architecture

› Live demo: ATAK + MOOS-IvP + Gazebo

› Route & waypoint command flow

› pTAKBridge ↔ Unmanned Marine Vehicle Plugin

MOOS External Interface (MEI)

Bridging MOOS-IvP with External Systems

The Problem

- Integrating external processes with MOOS requires writing a full MOOS app
- Low-level MOOS comms API can be complex
- No clean path for ROS 2, Python tools, or operator dashboards to pub/sub MOOS vars
- Bespoke bridges per project — not reusable

MEI Solves This

- Lightweight library — publish & subscribe to a MOOS community from any process
- No need to be a MOOS app; works from ROS 2 nodes, Python scripts, C++ daemons
- Clean minimal API hiding the MOOS comms layer
- Enables hybrid architectures spanning MOOS-IvP and ROS 2

MEI Architecture

Two bridge pairs — shared protobuf serialization

PRIMARY: ROS 2 ↔ MOOS-IvP Bridge

iMOOSGateway

TCP server running inside MOOS-IvP. Forwards configured MOOS variables to connected clients and accepts pub/sub data back into MOOSDB. Supports multiple simultaneous clients.

protobuf_client_ros2

ROS 2 node that connects as TCP client to iMOOSGateway. Deserializes protobuf messages to ROS 2 topics (/gateway_msg) and publishes ROS 2 ↔ MOOS data back over the same connection.

ALTERNATE CONFIGS

iMOOSClient

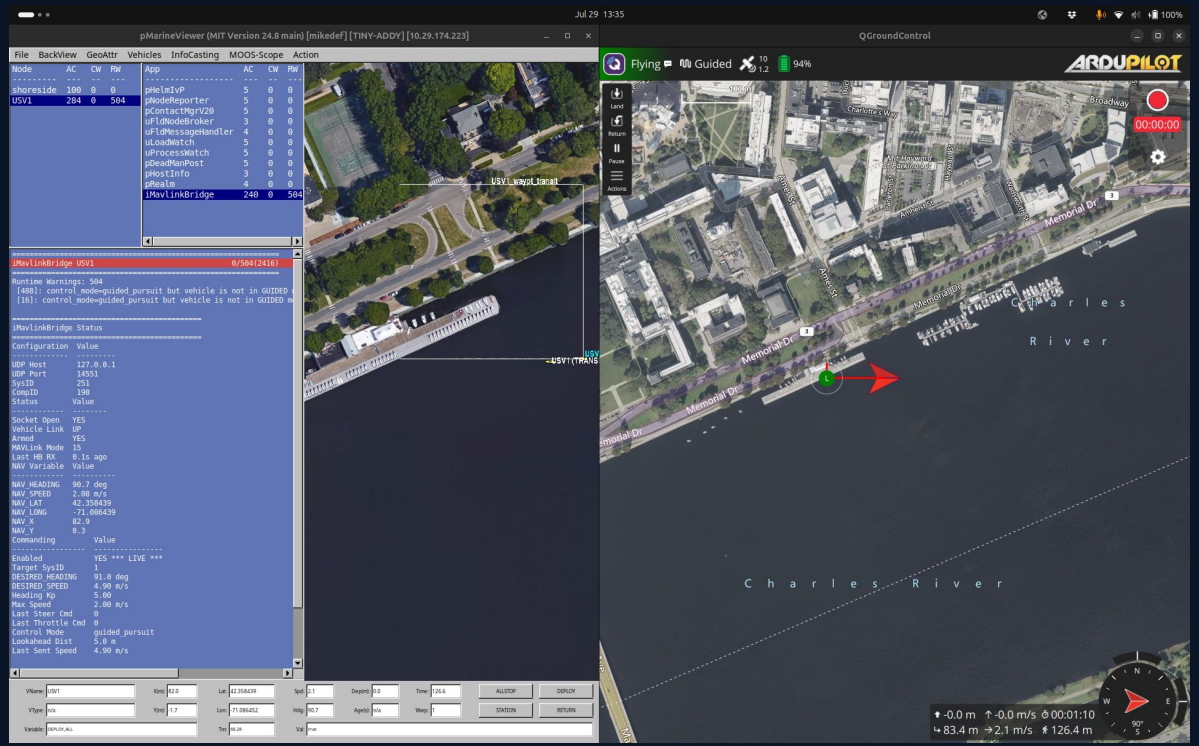
TCP client running inside MOOS-IvP. Inverse of iMOOSGateway — MOOS connects OUT to an external TCP server/relay. Used for shore-station aggregation and multi-vehicle coordination.

iMavlinkBridge

MAVLink ↔ MOOS bridge. Reads vehicle telemetry from ArduPilot/PX4 autopilots and populates NAV_X, NAV_Y, NAV_HEADING, NAV_SPEED in the MOOSDB for IvP Helm consumption. Publishes vehicle control to autopilot

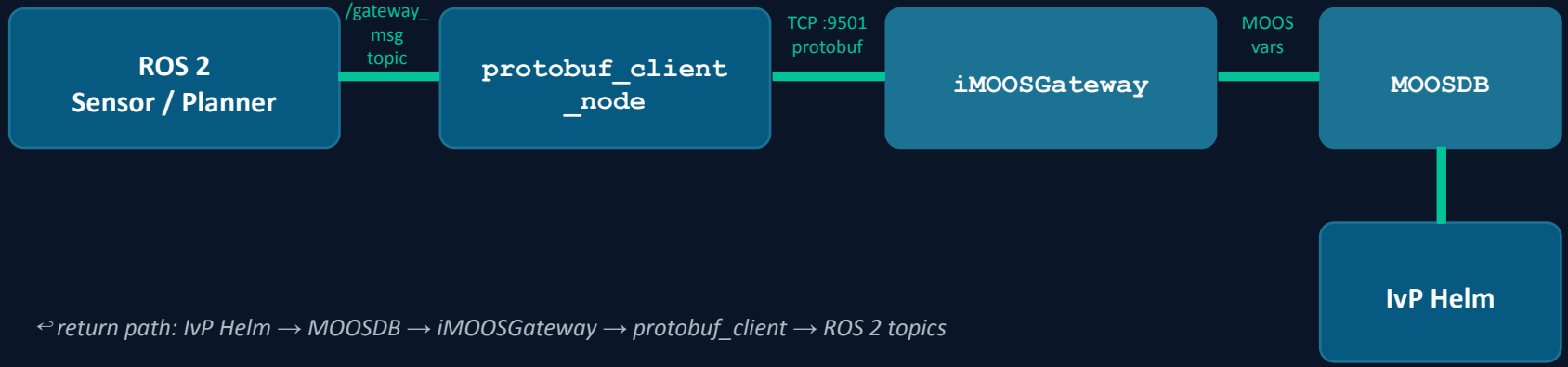
⬡ *iMOOS* and protobuf_client_ros2 use Protocol Buffer serialization for efficient, typed cross-process transport*

QGC + ArduRover with pMarineViewer



ROS 2 ↔ MOOS-IvP: Typical Bridge Setup

iMOOSGateway (TCP server) + protobuf_client_ros2 (TCP client)



↩ *return path: IvP Helm → MOOSDB → iMOOSGateway → protobuf_client → ROS 2 topics*

iMOOSGateway config (mission .moos)

```
forward_to_client = NAV_X, NAV_Y, NAV_HEADING, IVPHELM_STATE
block_from_client = DEPLOY
robot_id = $(VNAME)    |    AppTick = 50    |    tcp_port = 9501
```

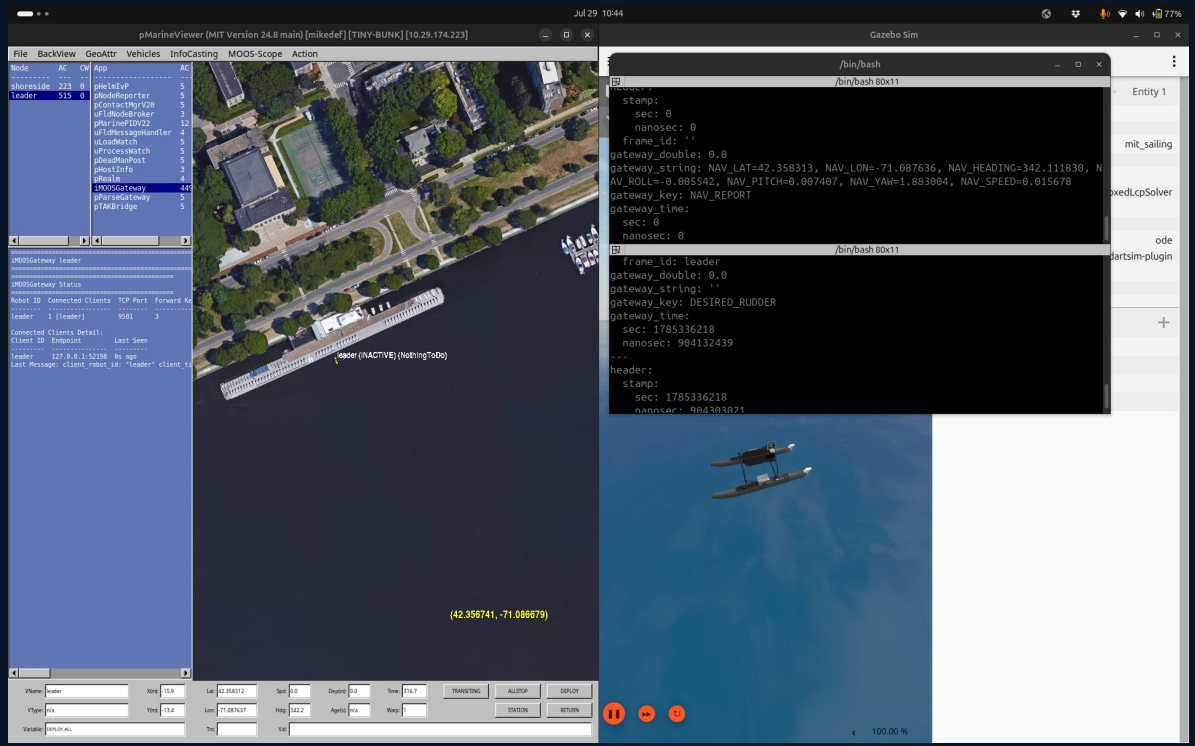
Screenshot suggestion: pMarineViewer + rqt_graph side-by-side showing live topic bridging

Multiple ROS 2 nodes can connect to a single iMOOSGateway simultaneously

⚠️ AppTick ≥ 50 — tick rate dominates end-to-end latency more than TCP transit time

iMavlinkBridge can replace or supplement protobuf_client for MAVLink autopilots

Gazebo Sim with pMarineViewer



PART 2

pTAKBridge & TAK Autonomy Integration

Connecting MOOS-IvP autonomous vehicles to the TAK operator ecosystem

The TAK Ecosystem

Widely adopted SA & C2 — defense and first responders

ATAK

Android-based TAK client — handheld SA with maps, contacts, and route planning

WinTAK

Windows desktop TAK client — command post, operator display

WebTAK

Browser-based TAK client — no install, accessible from any device

TAK Server

Central federation server — routes CoT messages between all clients

CoT XML

Cursor-on-Target — the underlying message format: position, tracks, events

Data Packages

Missions, routes, KML overlays shared across the TAK network

pTAKBridge Architecture

MOOS-IvP ↔ Cursor-on-Target (CoT) translation

What pTAKBridge Does

› Runs as a standard MOOS application — subscribes to community state

› Publishes vehicle position, heading, and contacts as CoT XML to TAK Server

› Receives TAK-side routes and operator commands — injects as MOOS variables

› IvP Helm behaviors respond to incoming waypoints without operator MOOS knowledge

› UDP / TCP transport — configurable TAK Server endpoint

Data Flow

`MOOSDB → CoT XML → TAK Server`

`TAK Server → CoT XML → MOOSDB`

`NAV_X, NAV_Y → sa-loc CoT`

`CONTACTS_SUMMARY → sa-pos CoT`

`TAK Route CoT → MOOS WPT_UPDATE`

ATAK UMV Tool Plugin

Unmanned Maritime Vehicle plugin — four operator actions, four MOOS variable mappings

Telemetry

MOOS → CoT sa-loc → ATAK

Live vehicle state streamed to operator — position, heading, speed, and IvP Helm mode displayed in the UMV panel.

```
NAV_X · NAV_Y · NAV_HEADING
NAV_SPEED · IVPHELM_STATE
```

Route Planning

ATAK → CoT → MOOS

Operator draws a waypoint route in ATAK and sends it to the selected vehicle as a CoT route package.

```
CoT route → WPT_UPDATE
posted to MOOSDB
```

Deploy

ATAK → CoT → MOOS

Activates the IvP Helm — vehicle begins executing its current mission behaviors. One-tap mission start from ATAK.

```
DEPLOY = true
MOOS_MANUAL_OVERIDE = false
```

AllStop

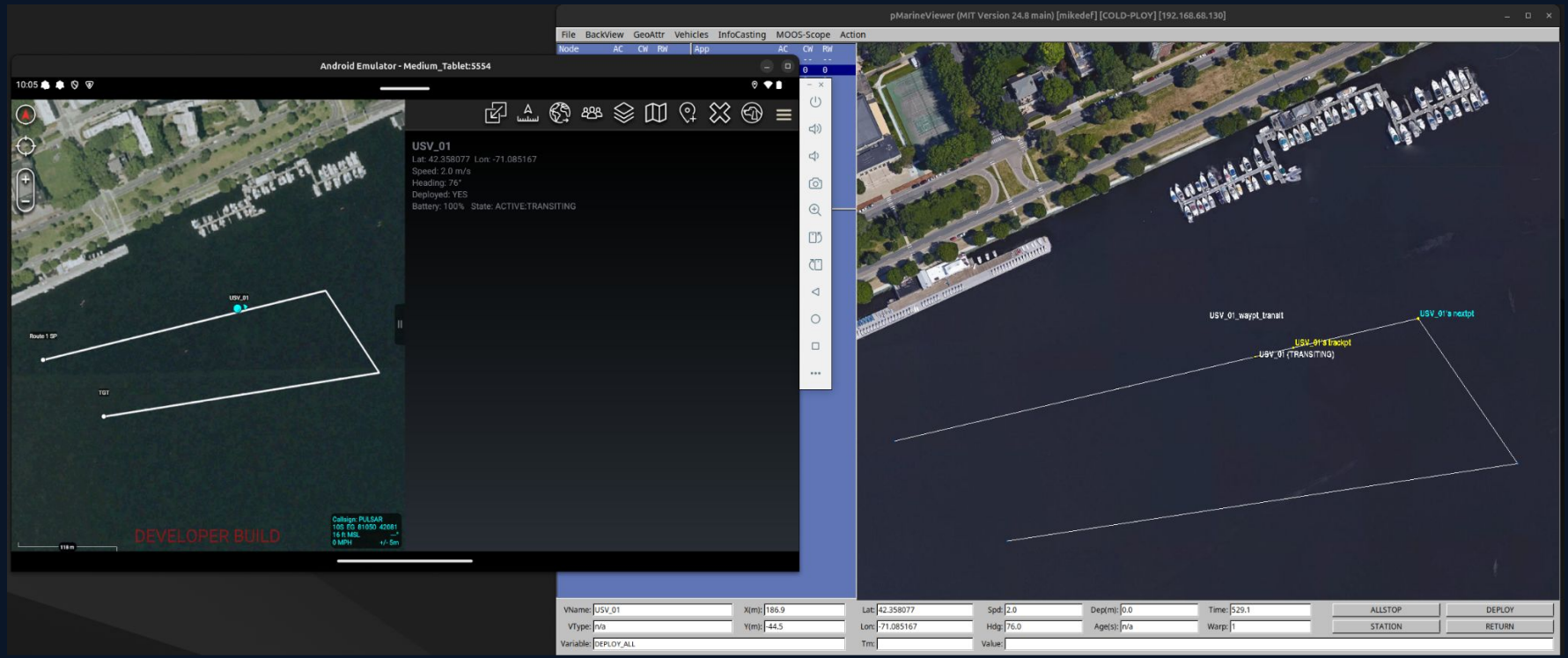
ATAK → CoT → MOOS

Emergency halt. Immediately overrides autonomy and brings the vehicle to a stop regardless of current behavior.

```
DEPLOY = false
MOOS_MANUAL_OVERIDE = true
```

ATAK UMV Tool

ATAK ⟷ MOOS-IvP



Live Demo Overview

End-to-end: TAK operator → MOOS-IvP → simulated WAM-V

ATAK UMV Tool (Android Emulator)
Operator draws route, selects vehicle

WebTAK (Browser)
Secondary SA view — all contacts visible

TAK Server
Federation — routes CoT between clients

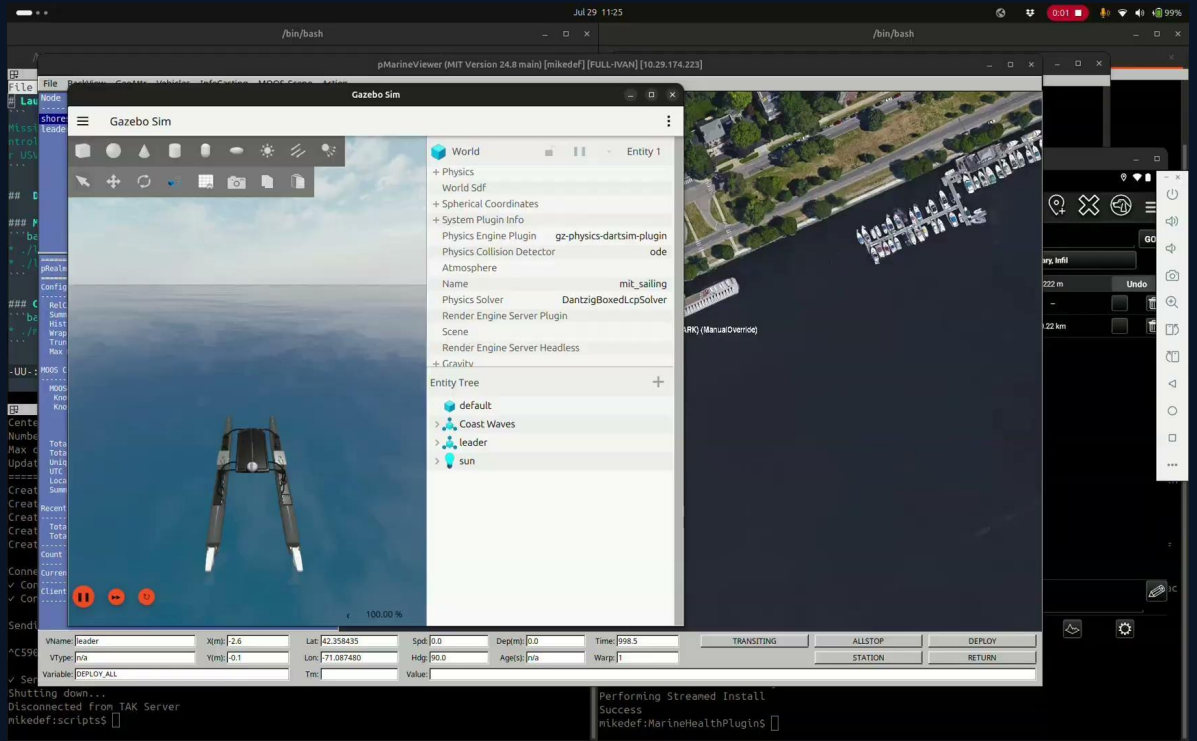
pTAKBridge (MOOS app)
Translates CoT route → WPT_UPDATE in MOOSDB

MEI / ROS 2 Bridge
iMOOSGateway subscribes, publishes to ROS 2 topics

Gazebo — WAM-V Sim
ROS 2 nav stack drives simulated vehicle to waypoints

Live Demo Notes

Backup Demo Video



Demo Day

Come see pTAKBridge in action

- Live demo running at the Demo Day table — MOOS-IvP + TAK end-to-end
- Simulated WAM-V running in Gazebo, controlled via ATAK on Android emulator
- Watch vehicle telemetry stream live into ATAK — position, heading, IvP Helm state
- Send a waypoint route from ATAK and watch the vehicle execute the mission
- Interested in MEI or pTAKBridge for your platform? Come talk to us

mikedef@mit.edu · supun@mit.edu · github.com/mikedef

Thank You

MOOS External Interface:	github.com/mit-moos-gateway/
pTAKBridge:	github.com/tak-autonomy
MAL Lab:	oceanai.mit.edu/pavlab/pmwiki/pmwiki.php
AUV Lab:	seagrant.mit.edu/auv-lab/
Contact:	mikedef@mit.edu | supun@mit.edu

Questions?