

Digital Twin: a bridge between simulation and real world in the Maritime Environment

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STO-MP-MSG-207



SCIENCE & TECHNOLOGY ORGANIZATION
OFFICE OF THE CHIEF SCIENTIST CH AND EXPERIMENTATION

Introduction

“

NATO is reinforcing its maritime posture and is taking concrete steps to improve the Alliance’s overall maritime situational awareness, deter and defend against all threats in the maritime domain, uphold freedom of navigation, secure maritime routes and protect its main lines of communication.

— [NATO HQ](#)

”

What is it all about?

Aim of collaboration with IT-Navy

Is DT applicable for the underwater domain?

Is it useful for the nations?

- Propose uses for DT in underwater autonomy
- Investigate an architecture that addresses scenarios

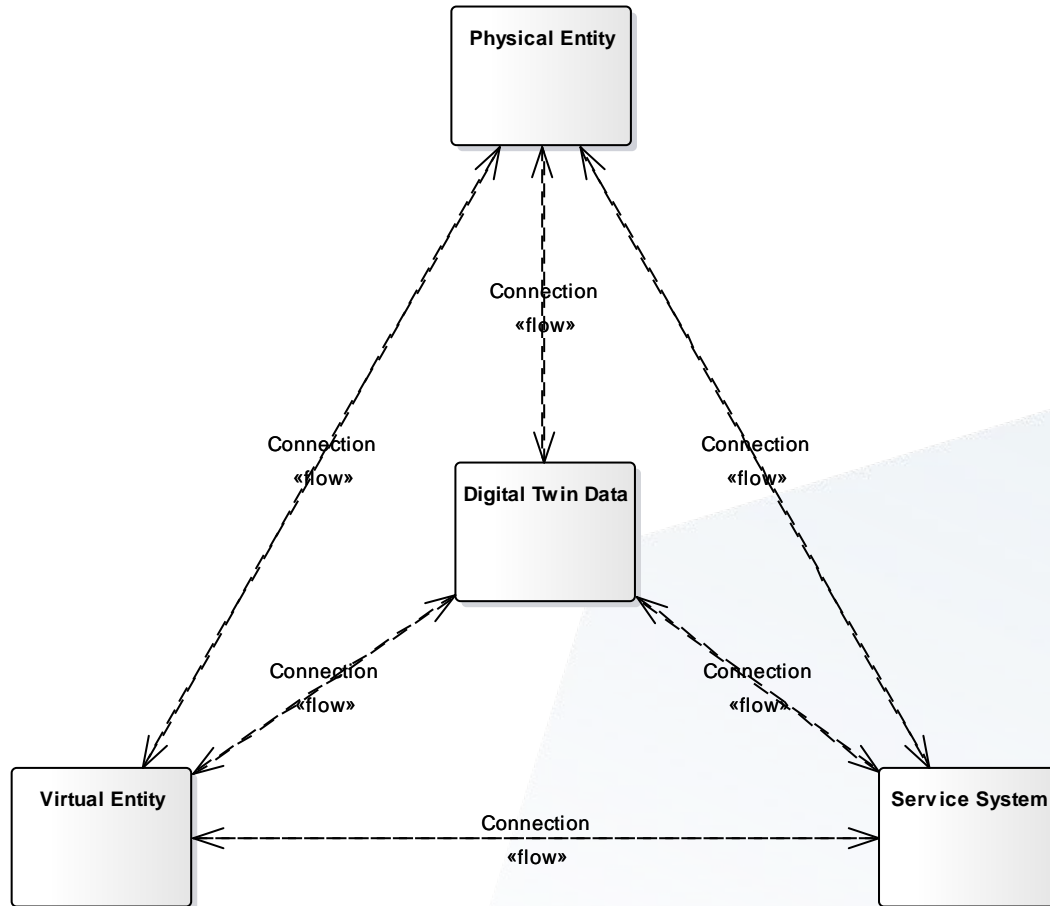
Environment characteristics

- Limited communication
- No GPS
- No light

Key:

- Explored
- Unexplored

State of the Art



Health management / Maintenance

Monitoring

Industrial process optimization

Environment

Mission engineering/combat effectiveness

Augmented Testing

Training

UNDERWATER

Monitoring in absence of comms

02. Methods

Standards

- DSEEP
- NAF
- Spiral and Agile Development

	Baseman	Structure	Connectivity	Processes	Behaviour	Sequences	Information	Constraints	Realmap
Concepts	Capability Taxonomy NS-2, NS-1	Enterprise Vision NS-1	Capability Dependencies NS-2	Standard Processes NS-3	Effects NS-4	Performance Parameters NS-5	Planning Assumptions NS-6	Capability Roadmap NS-7	
Service Specifications	Service Taxonomy NS-2, NS-1	Service Interfaces NS-2	Service Functions NS-3	Service States NS-4	Service Interactions NS-5	Service Parameters NS-6	Service Policy NS-7	Service Roadmap NS-8	
Logical Specifications	Node Types NS-2	Logical Schemas NS-2	Node Interactions NS-2, NS-3	Logical Activities NS-3	Logical States NS-4	Logical Sequence NS-5	Logical Data Model NS-7	Logical Constraints NS-8	Lines of Development NS-9
Physical Awareness Specifications	Awareness Types NS-2	Awareness Structure NS-2, NS-1	Awareness Connectivity NS-2, NS-3	Awareness Functions NS-3	Awareness States NS-4	Awareness Sequence NS-5	Physical Data Model NS-7	Awareness Constraints NS-8	Configuration Management NS-9
Architecture Meta Data	Meta Data Definitions NS-2	Architecture Products NS-2	Architecture Dependencies NS-2	Methodology Used NS-2, NS-3	Architecture Status NS-4	Architecture Variants NS-5	Architecture Meta Data NS-7	Standards NS-8	Architecture Roadmap NS-9



▲ C3MRE test

Today

Aim(s): bridge with C2 for REPMUS (CATL), MOOS adapter for ASW, get ready for REPMUS



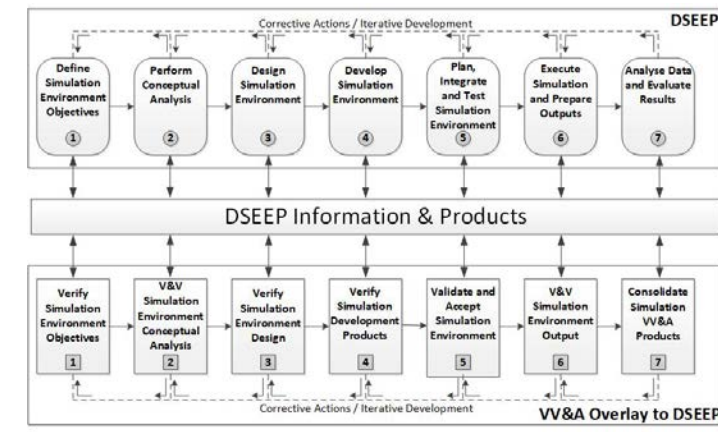
▲ REPMUS End



Aim(s): Update Sensor

MUSE Demo

Reporting



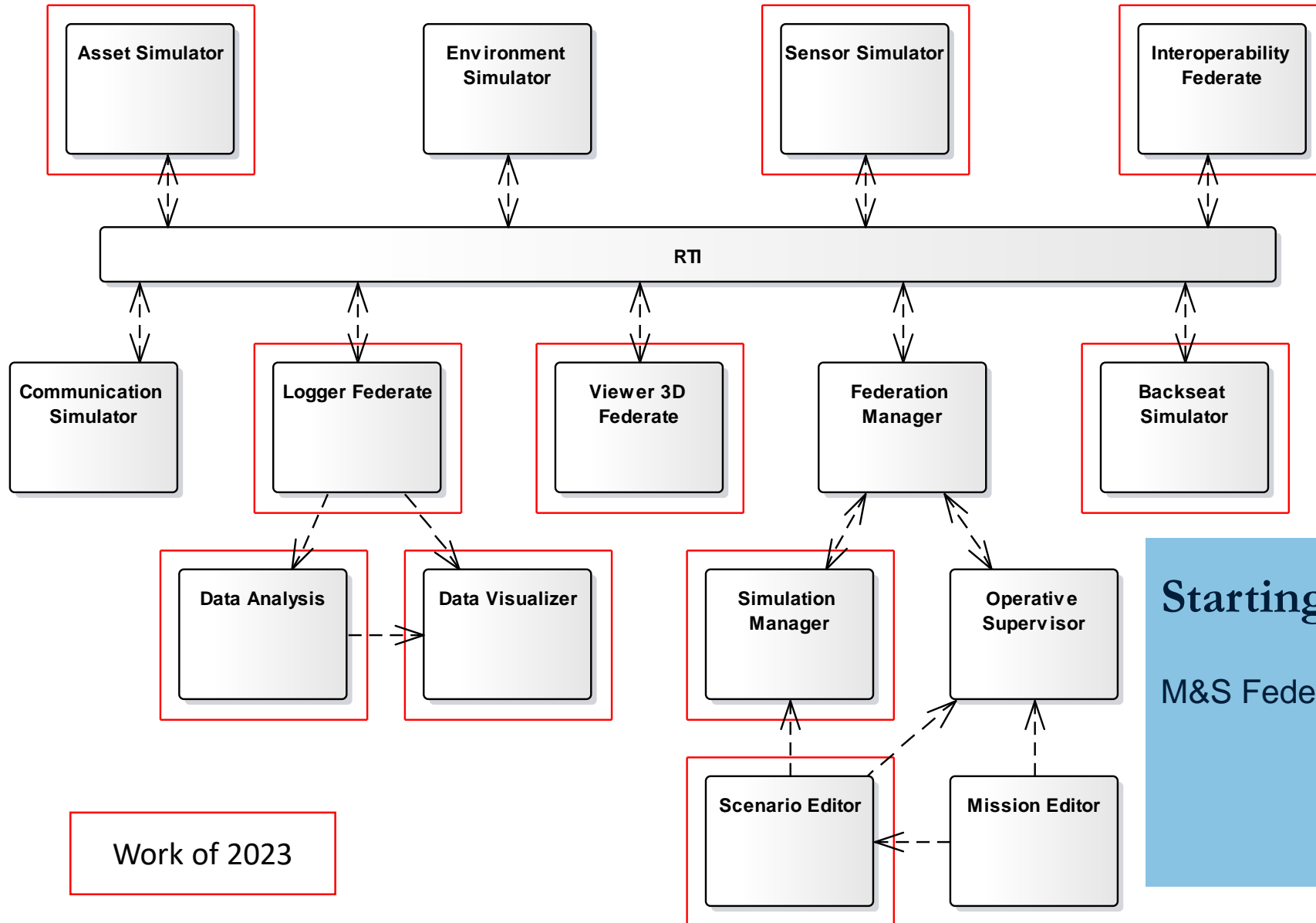
Collaboration

ITAN

- CSSN – Centro Supporto e Sperimentazione Navale
- Meetings: recurring weekly
- Aim: Definition and Validation of the scenarios

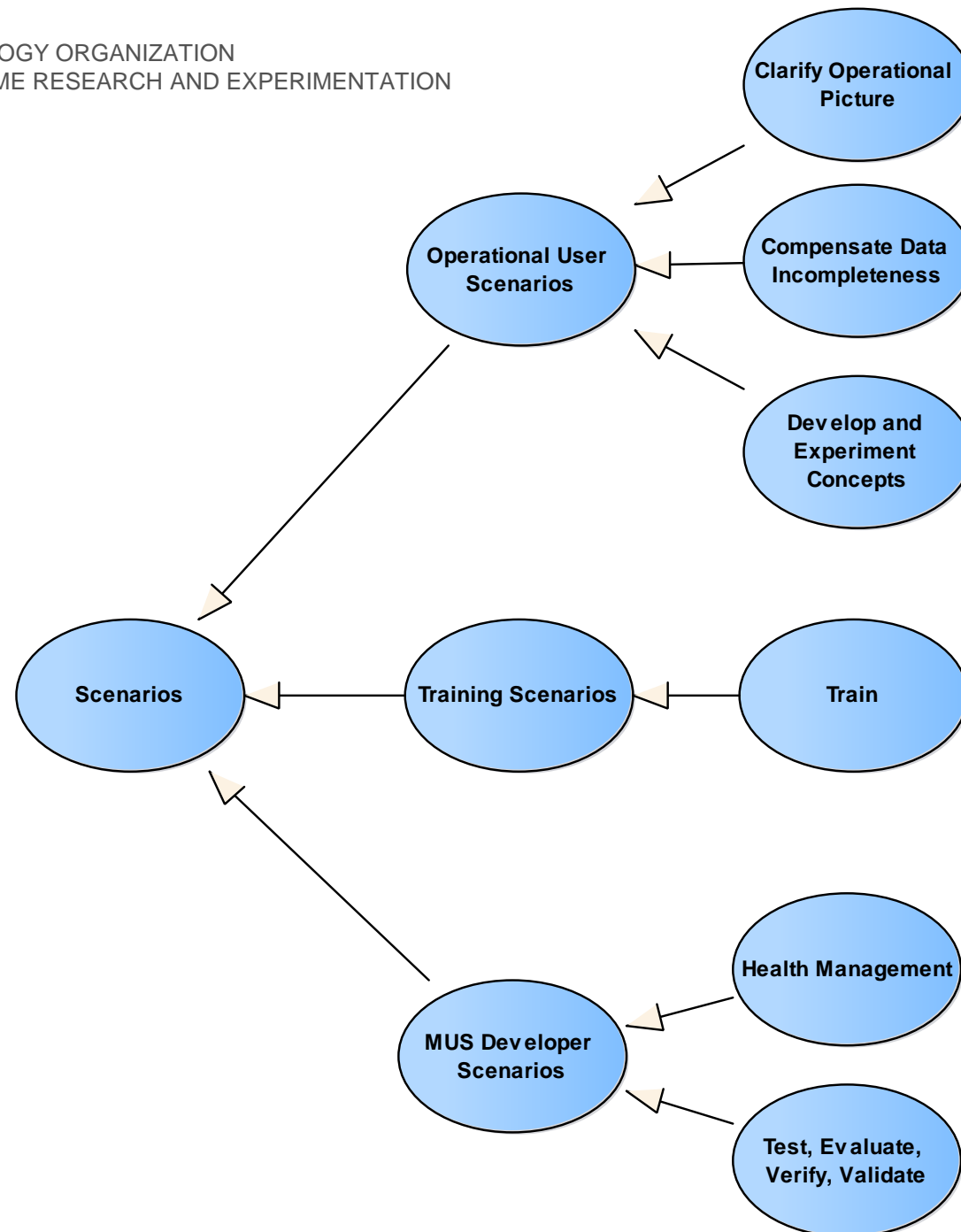
Industry

- Leonardo
- Fincantieri





03. Results

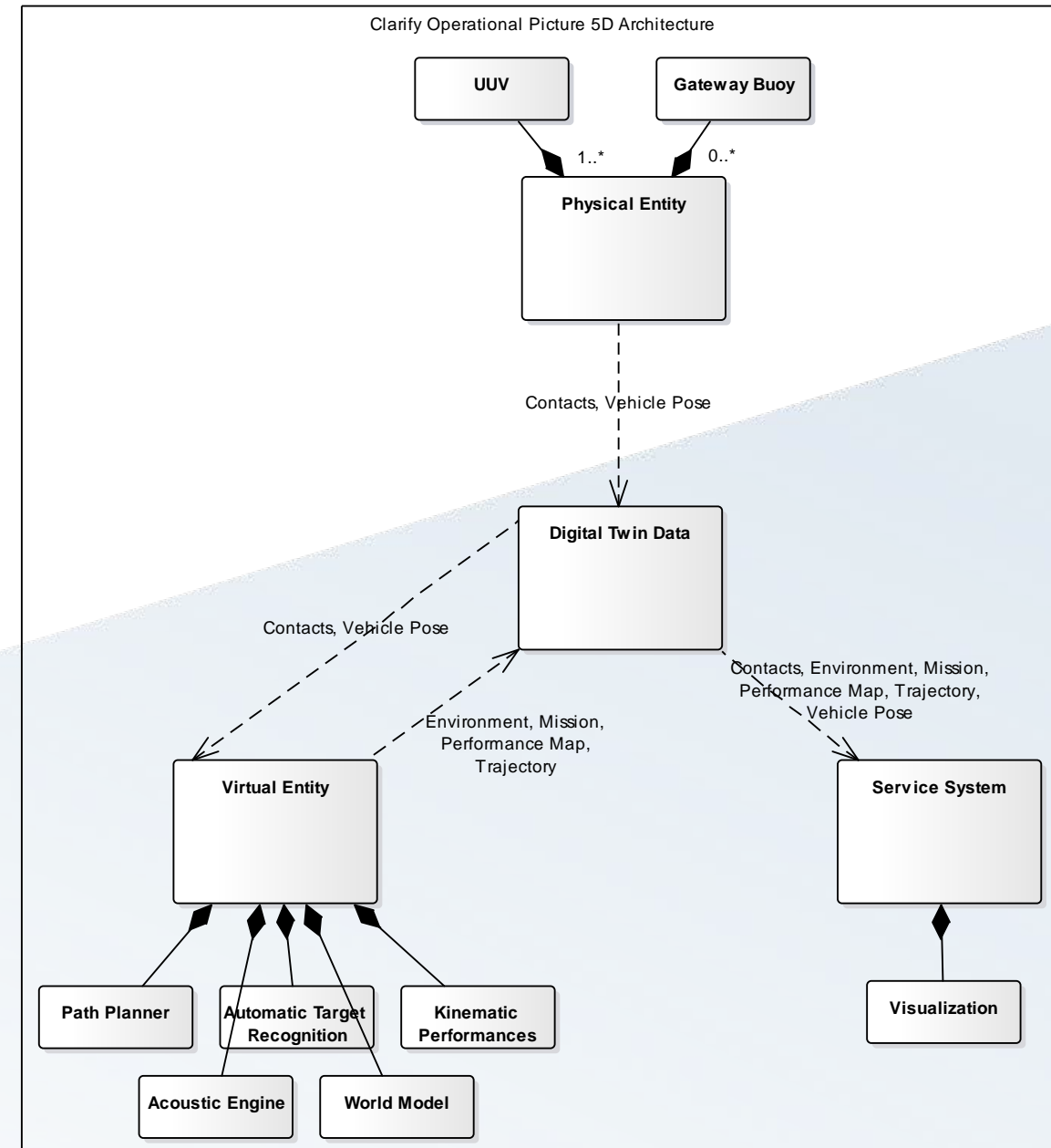
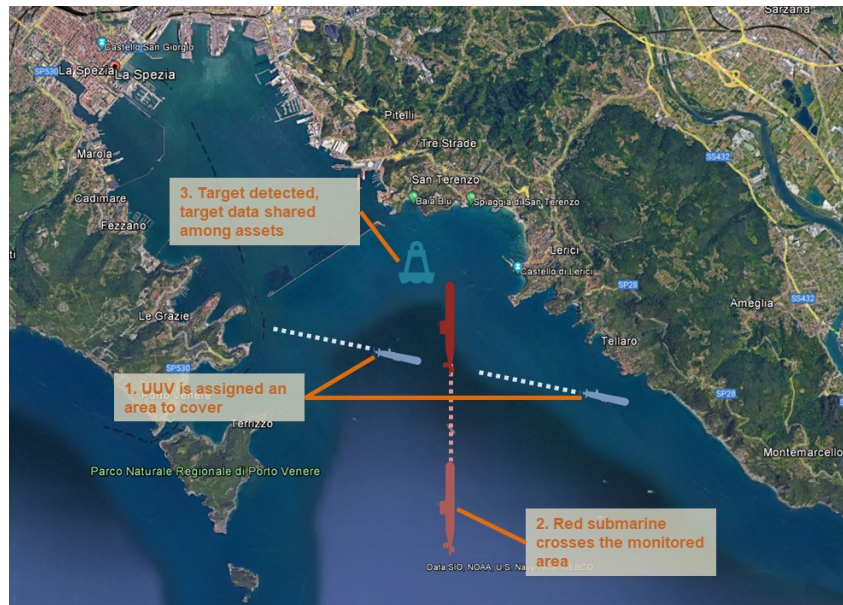


Scenarios

3 end users, 6 scenarios

Scenario 1: Clarify Operational Picture

Lack of communication during underwater operations leaves the operator of a MUS fleet blind for consistent portion of the mission duration



Why is it relevant to clarify the operational picture?

Land/Air operation

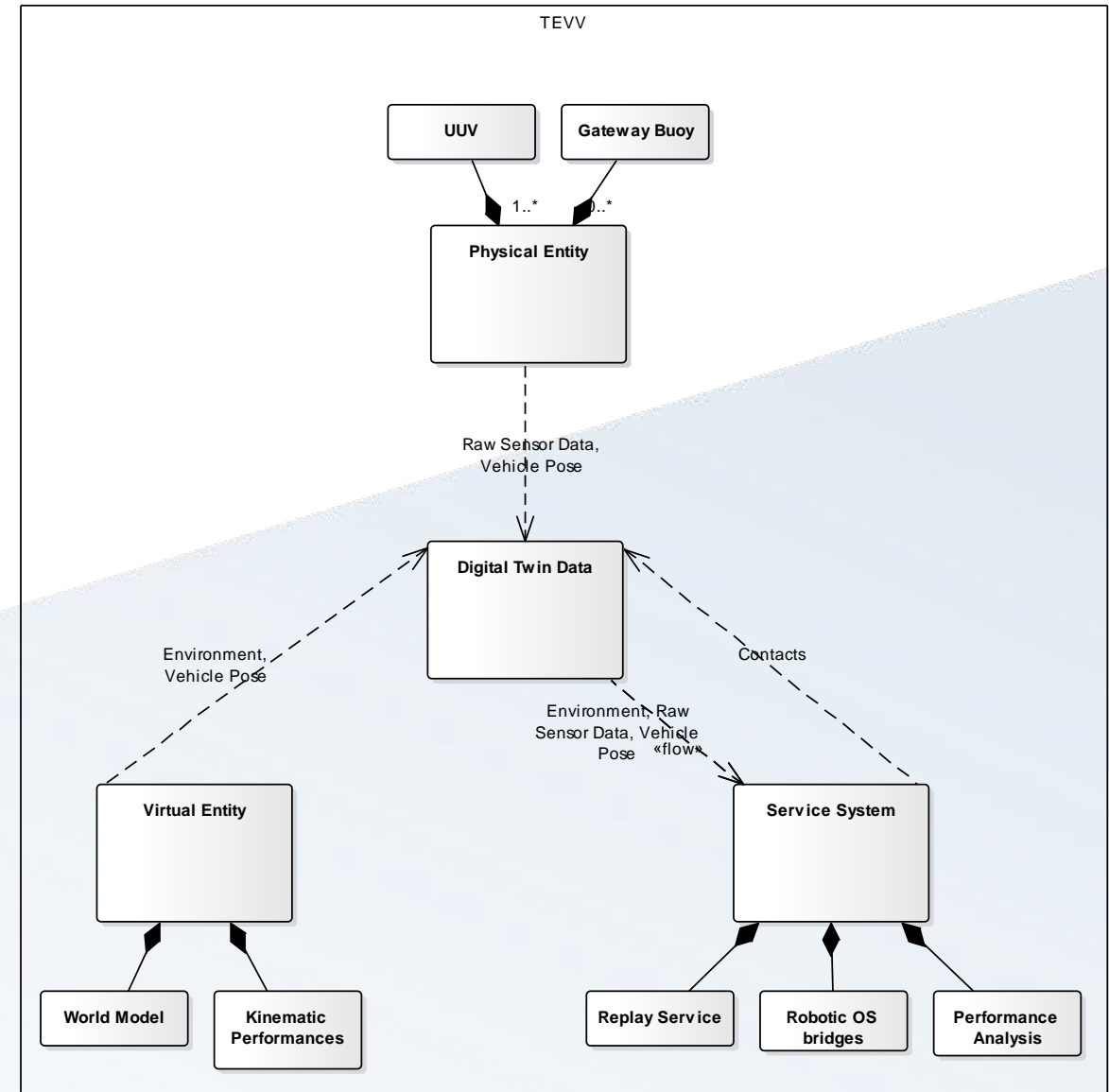


Underwater Operation



Scenario 2: Test Evaluate Verify and Validate

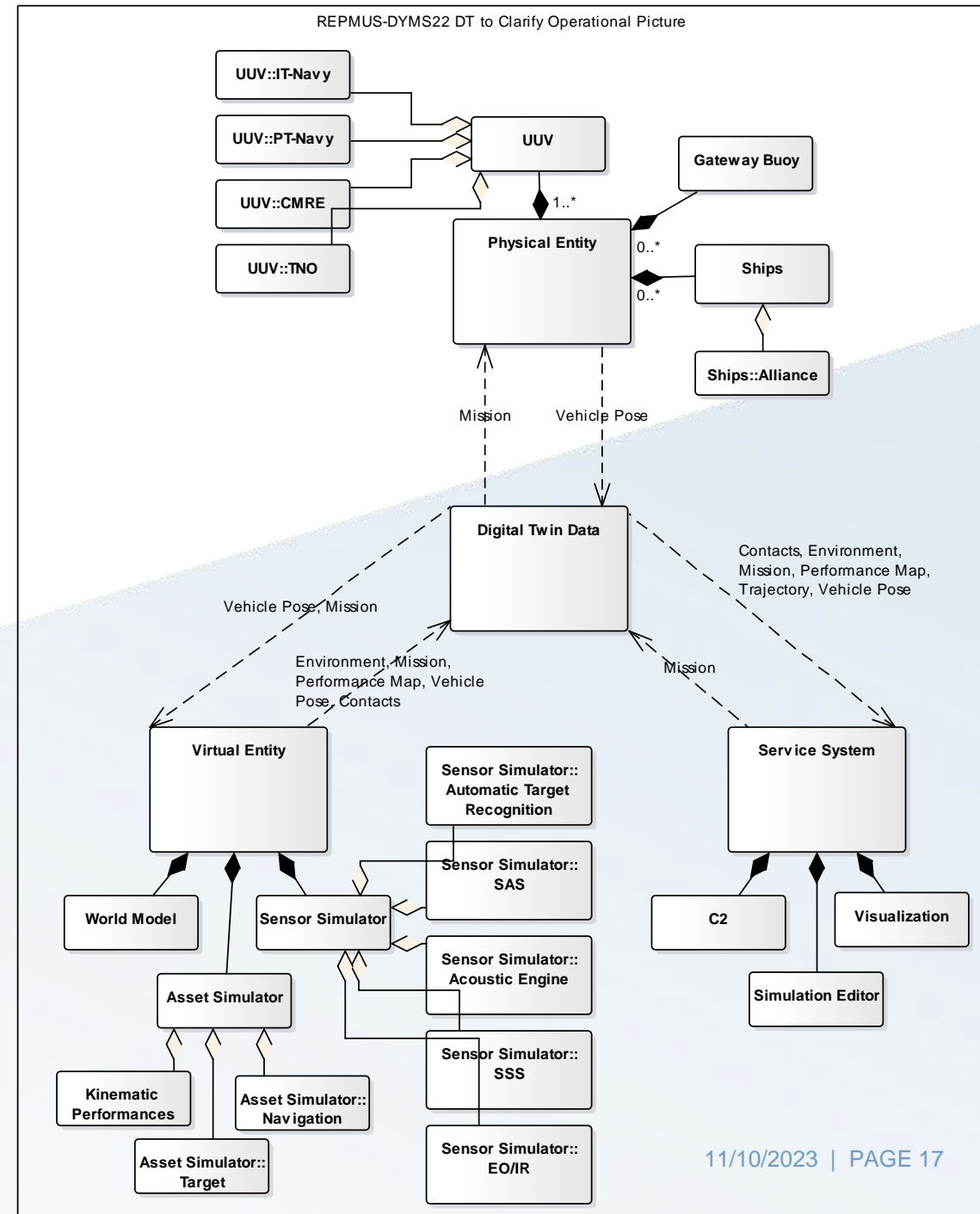
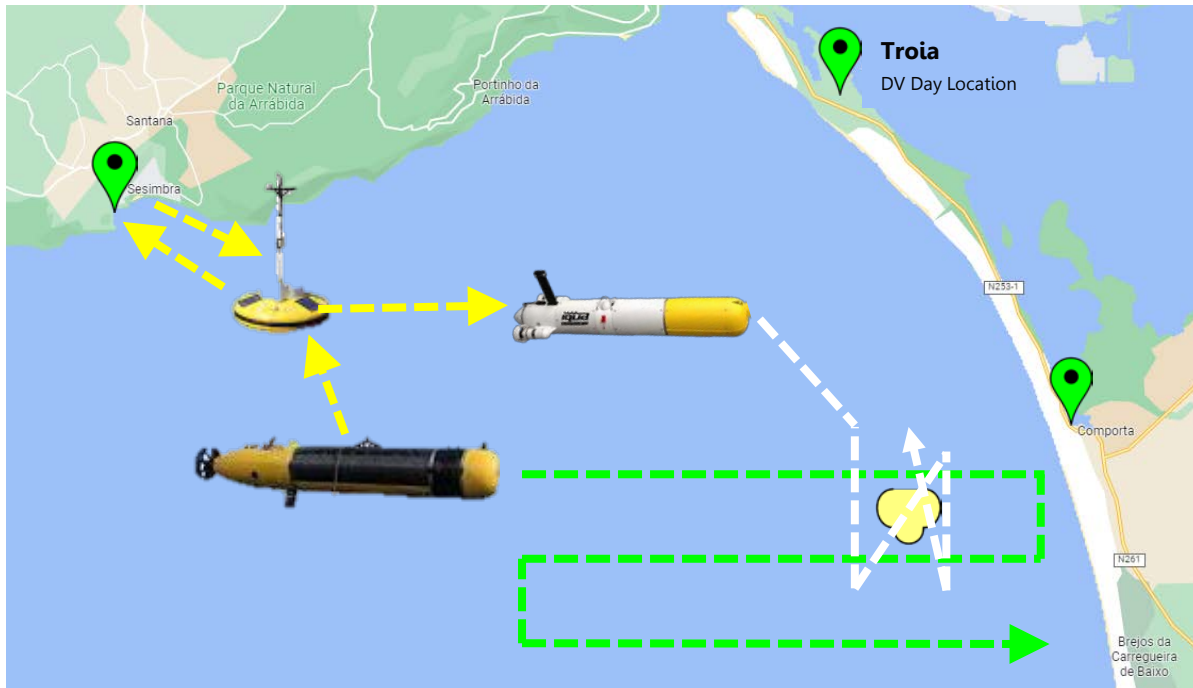
Use raw data collected during operations to test systems update and validate and verify deployment of new AI modules before going at sea



04. Discussion

MCM/ASW - use M&S DT to clarify the common operational picture during the exercises

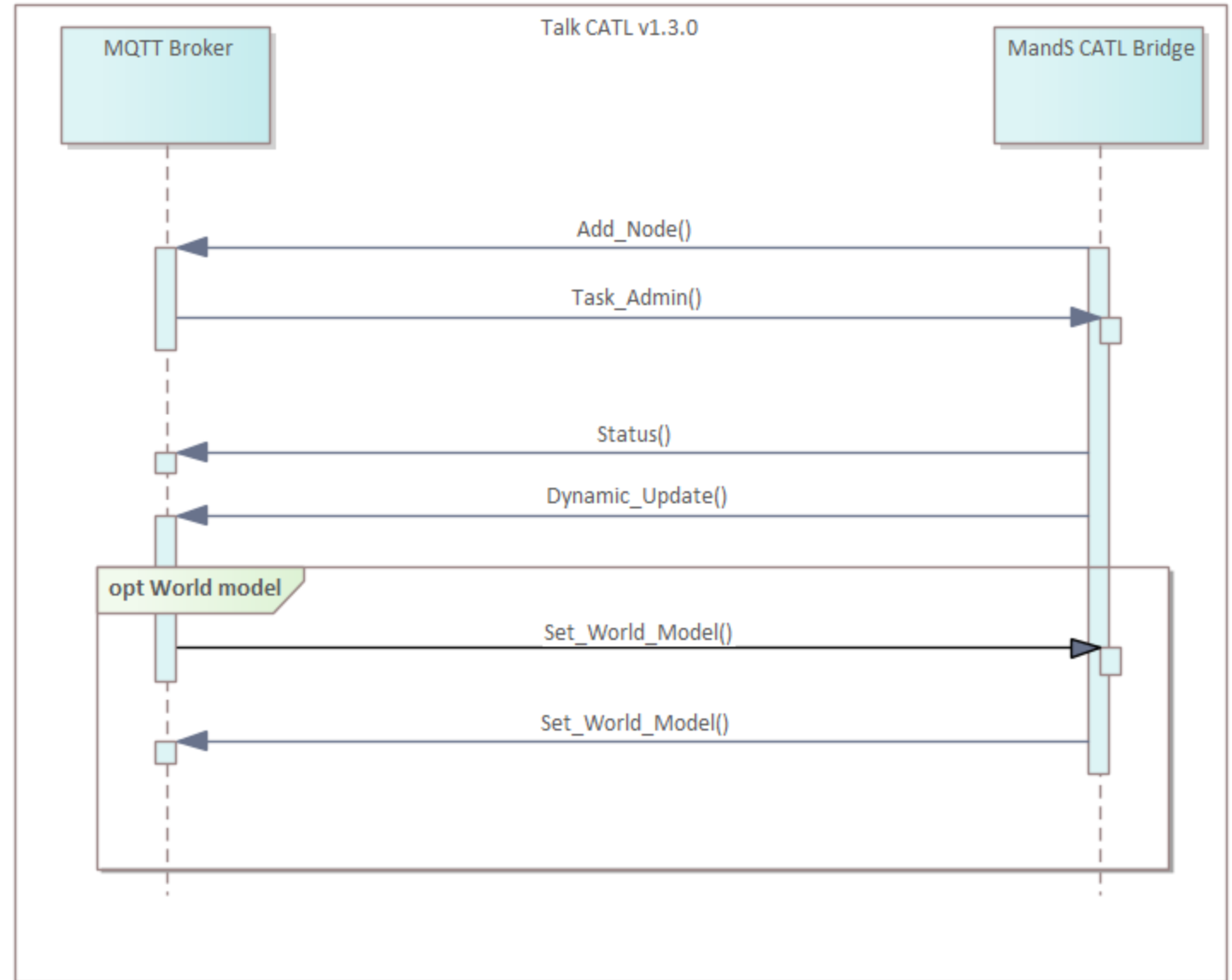
- **Visualize** real assets in a 3D realistic environment
- **Augment** real assets with simulated assets executing a parallel mission (ghosting) to highlight discrepancies between realistic operational conditions and initial planning conditions
- **Augment** real assets with simulated sensors to simulate detection performances

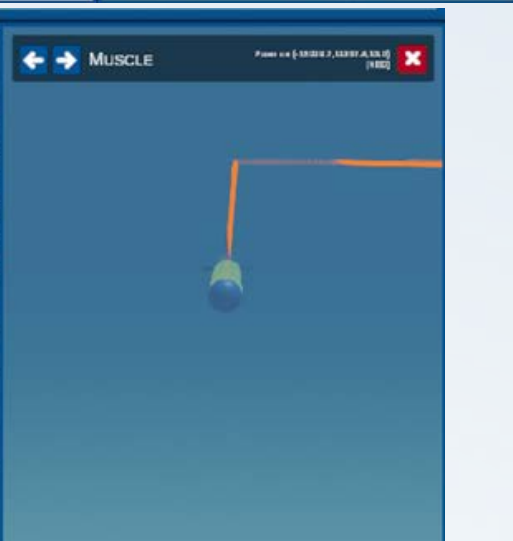
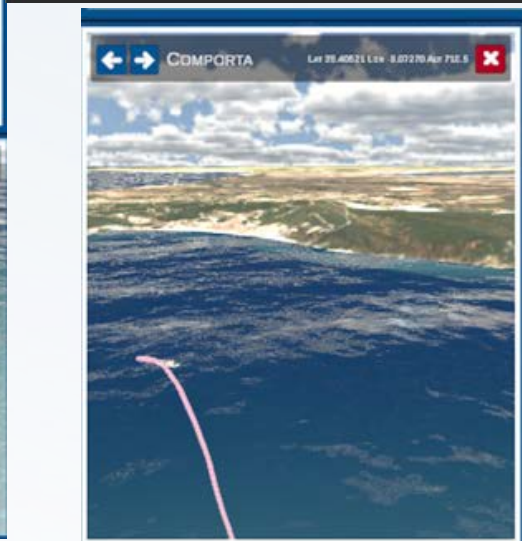
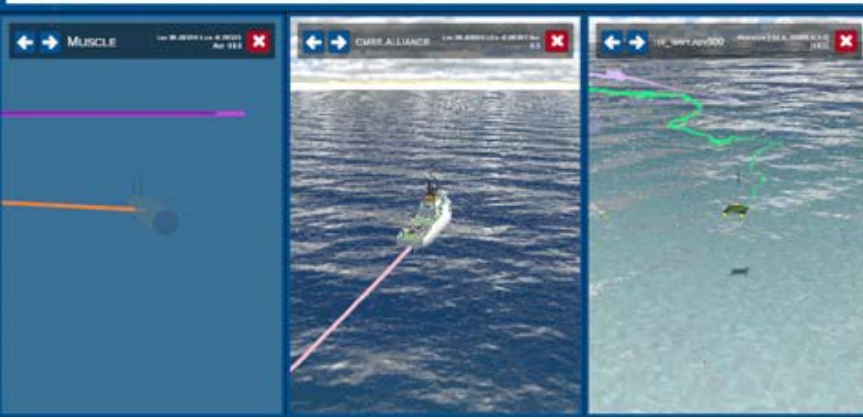
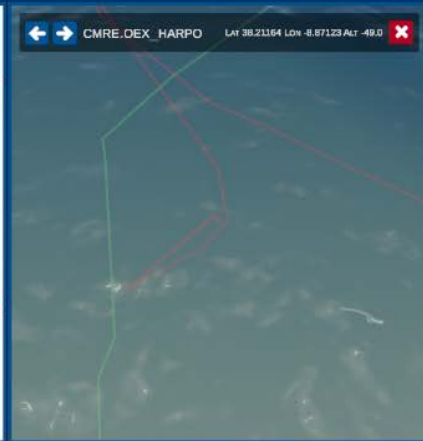
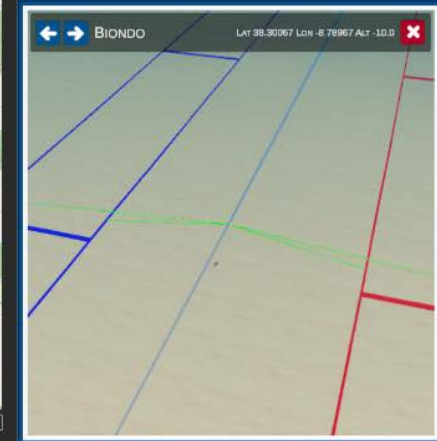
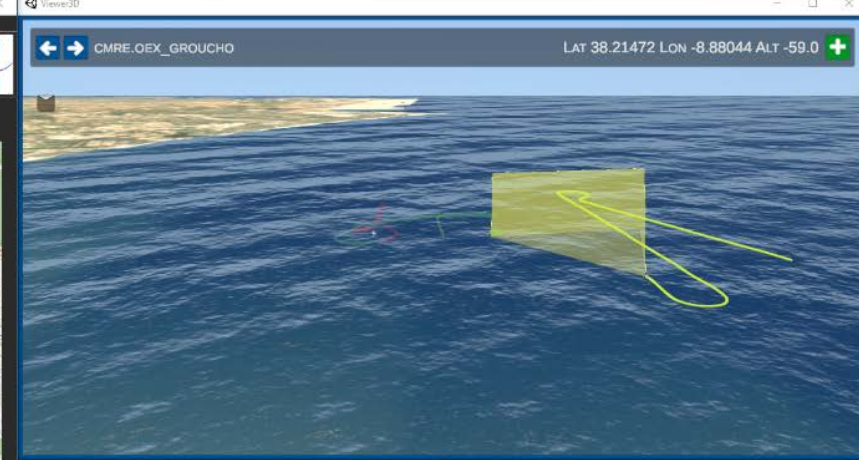
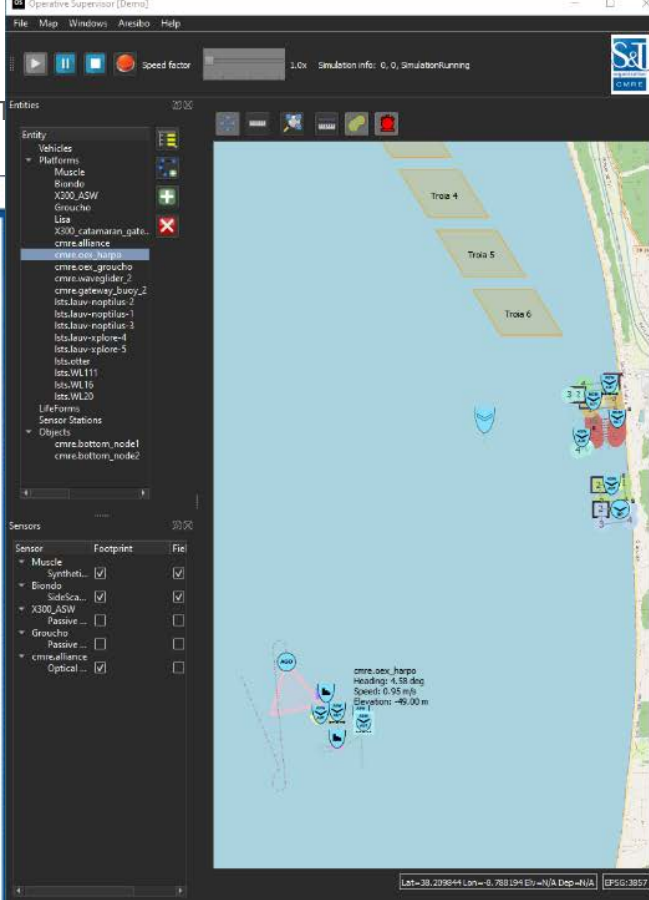
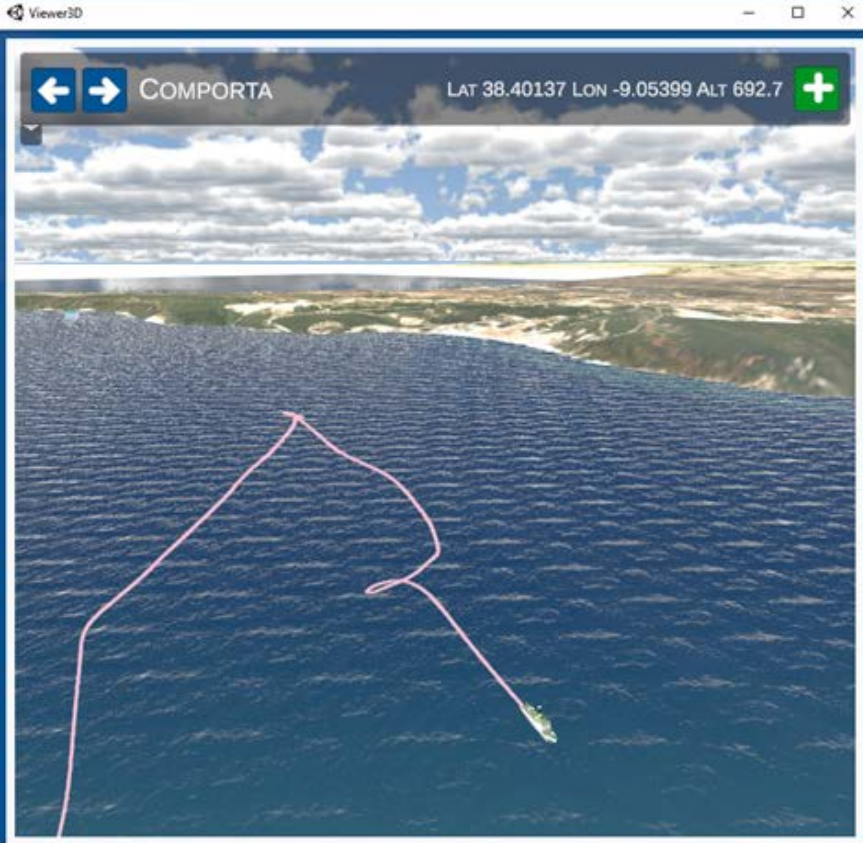


sd Talk CATL v1.3.0

C2 to Simulation

- **Status:** Telemetry from and to C2
- **Task Admin:** MCM survey, MCM identification missions from C2
- **Dynamic Update:** Contacts and detections from and to C2
- **World Model:** Regions, missions





05. Conclusion

Conclusion

- There is a strong interest in the operational community
- It is doable to develop a DT for UW scenarios
- It brings added value
- Working prototype deployed