Innovative Interoperable M&S within Extended Maritime Domain for Critical Infrastructure Protection and C-IED

La Spezia, Italy

CMRE

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Centre for Maritime Research and Experimentation (CMRE)

NATO Science and Technology Organization

CMRE is an established, world-class NATO scientific research and experimentation facility located in La Spezia, Italy.

*CMRE was formerly known as the NATO Undersea Research Centre (NURC).*

NATO STO CMRE

CMRE staff is about 150 people with over 100 among scientists and engineers conducting state-of-the-art scientific research and experimentation ranging from concept development to prototype demonstration in an operational in ocean science, modeling and simulation, acoustics and other disciplines. Since 2012 CMRE is customer funded.

CMRE operates two ships, NRV *Alliance*, a 93-meter 3,180-ton open-ocean research vessel, and CRV *Leonardo*, a smaller ship designed for coastal operations.

In addition to its laboratories the Centre is equipped with a fleet of autonomous underwater and surface vehicles.

CMRE uses several M&S Solutions able to support Capability Assessment and Education and Training.
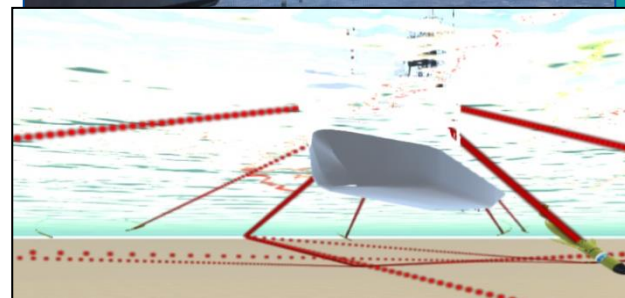
SIM LAB at NATO STO CMRE

CMRE extended his SIM Lab focusing on MS2G (Modeling and interoperable Simulation & Serious Games) including DVx2 for DAT (CIED/EOD)

Defence Against Terrorism

Distributed Virtual Experience & Exercise

DVx2 is a Virtual Interactive Exercise enabling NATO DAT PoW, Subject Matter Exerts (SMEs) and NATO Executives to demonstrate, validate, benchmark & appreciate the Defense Against Terrorism accomplishments

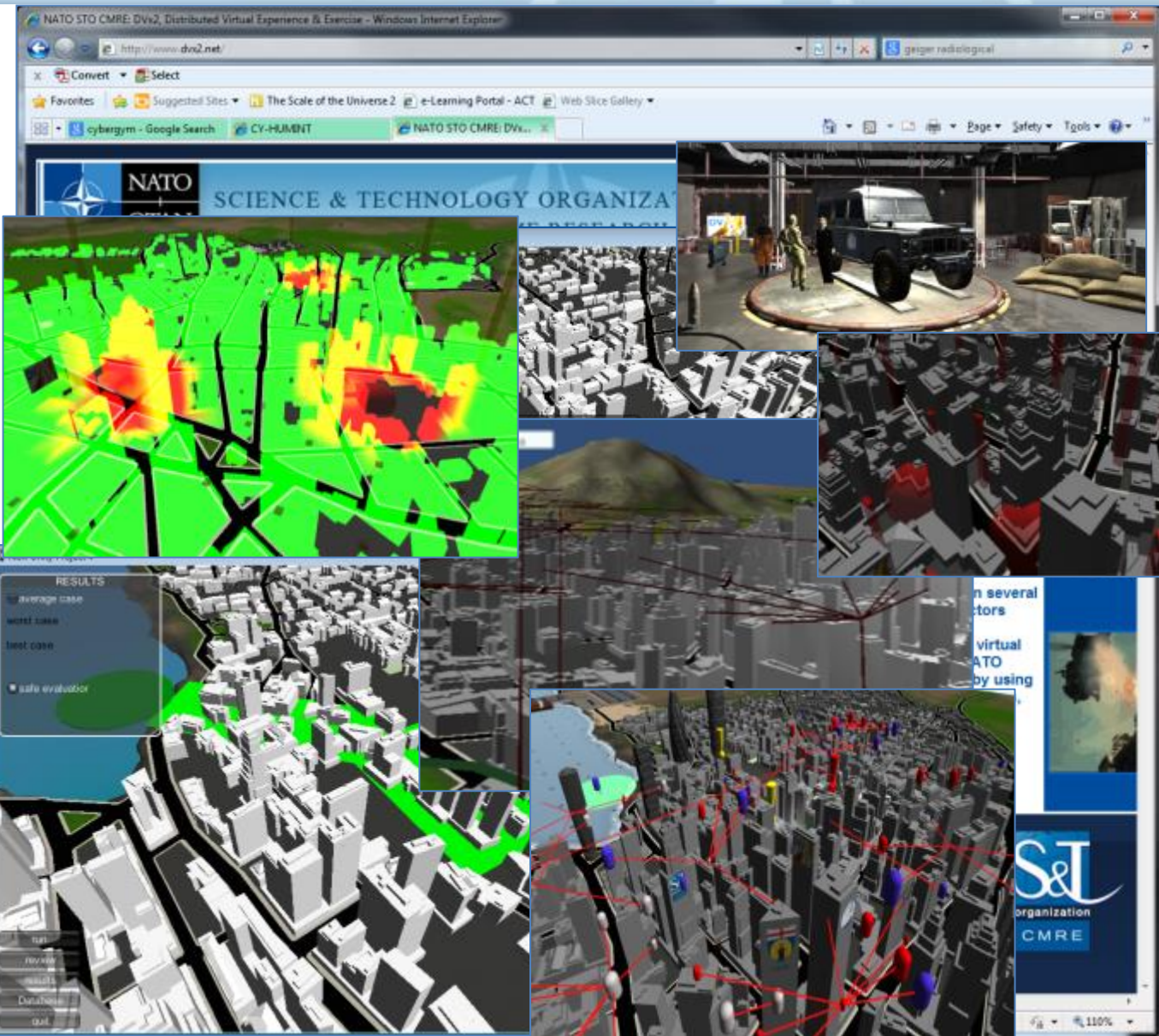## DVx2 Objectives and future developments:

- *Recognition and Identification* of *DAT Achievements* and *existing Gaps*
- *Benchmarking* among accomplishments in *Emerging Technologies* and *Capabilities* across the spectrum of *NATO DAT PoW* efforts
- *Engagement of NATO's Growing Community* of experts in a *Single Exercise*
- *Demonstration* of *NATO DAT activity progress* to *General Audience*
- *Engagement of DAT SME* by *Net Connectivity & Crowdsourcing*
- *Knowledge Solicitation on Defense Against Terrorism*
- *Virtual Exercising & Gaming applied to DAT and Strategic Alliance Initiatives*
- *Capability Development* for being extended to cover *whole NATO DAT PoW*
- *Realistic Impression* of progress made against terrorism on the *DAT PoW subjects*
- Creation of an *Interactive Scenario Repository for DAT PoW*
- Support *Future DAT Planning*
- Exploitation of CMRE as first case of applying *SaaS to SMEs*
- *Follow up of these concepts and achievements in NATO*
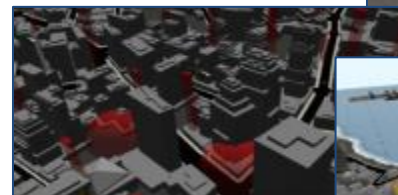
DVx2 drives Virtual Terrorists & Defenders by using Intelligent Agents

DVx2 enables to generate *Tests and Experience, by Simulation as a Service (SaaS) paradigm,* on improvements and challenges such as *Vulnerability Reduction, Technological and Organizational Advances*, etc.

DVx2:Distributed Virtual Experience & Exercise
www.cmre.nato.int/research/modelling-a-simulation

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DVx2
Distributed Virtual eXperience and eXercise

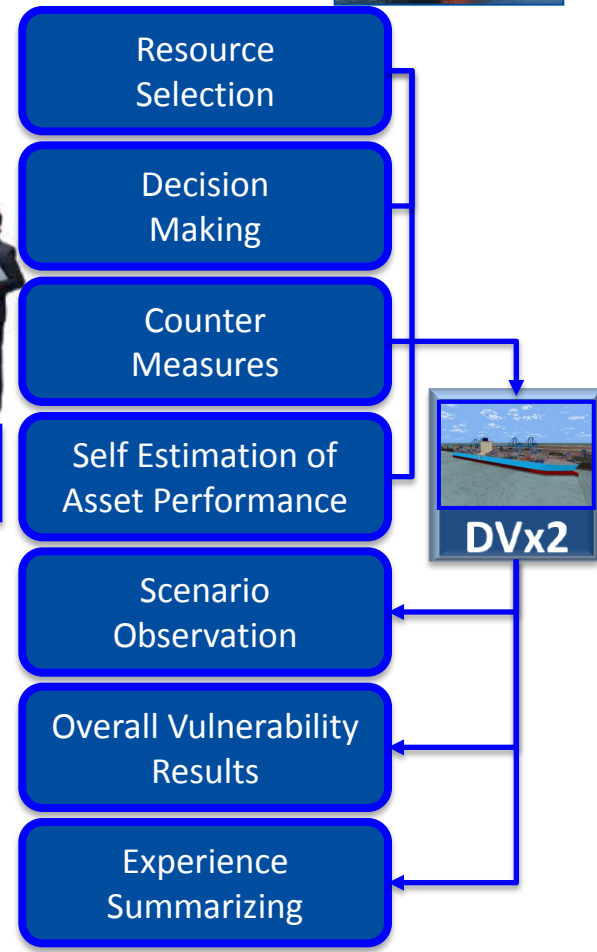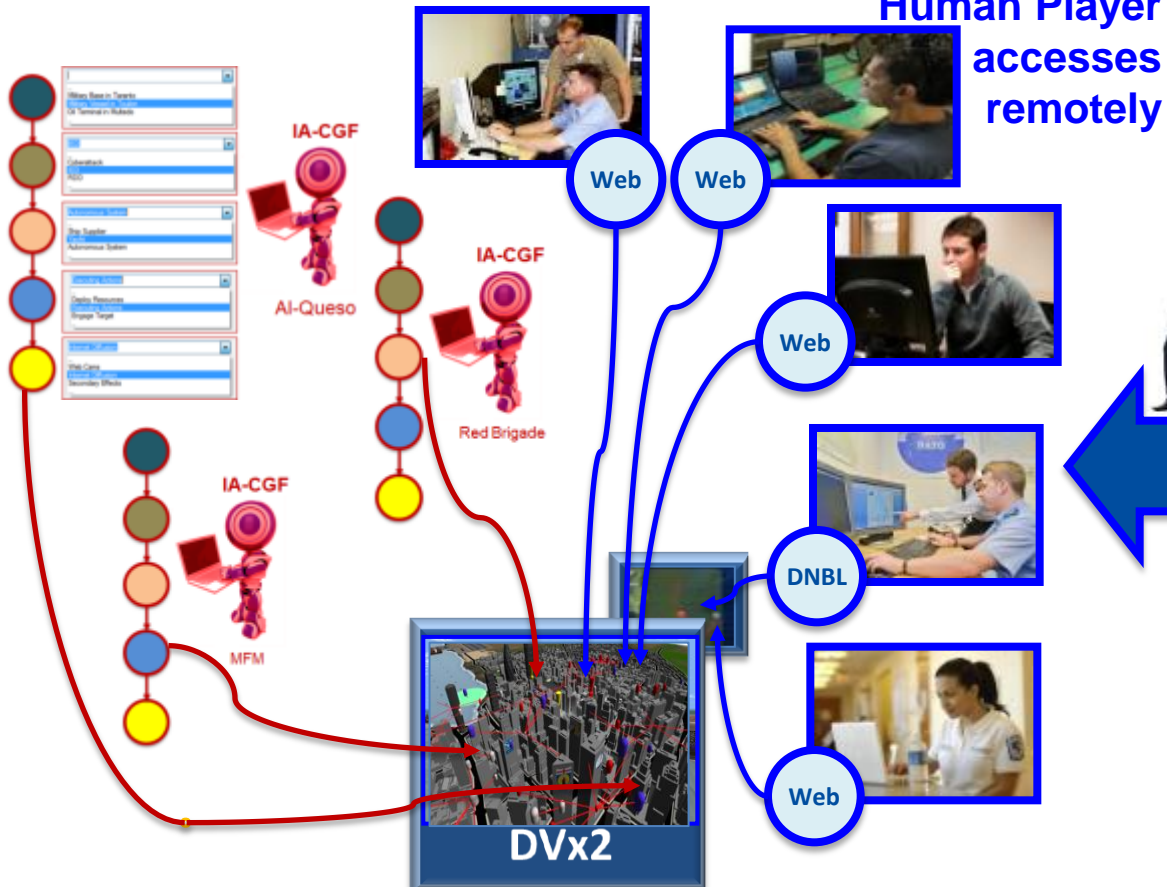**DVx2 focuses on M&S for Defence Against Terrorism :**
- **C-IED/EOD**
- **CBRN**
- **JISR**

2014-2015: DVx2 as a Simulation as a Service (SaaS) Solution for Experiencing & Exercising the Defence Against Terrorism (DAT) on the Web Supporting Crowsourcing

www.dvx2.net

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DVx2
Distributed Virtual Experience and Exercise

Human Player accesses remotely

IA-CGF

Al-Queso

IA-CGF

Red Brigade

IA-CGF

MFM

Web

Web

Web

DNBL

Web

DVx2

Resource Selection

Decision Making

Counter Measures

Self Estimation of Asset Performance

Scenario Observation

Overall Vulnerability Results

Experience Summarizing

DVx2

The Player evaluations allow to create a benchmark among different users and to test different approaches against Terrorist Attacks and Homeland Security Threats

M&S and Evolution of Table Top Ideas for Future Marine IED Challenges

- **MS2G** (Modeling, Interoperable Simulation, Serious Games)**: web based to prepare & communicate with participants the exercise (rules, tips, objectives)**

- **HLA Federation**
- **Real vs Sim vs Real***
- **Cyber Layer**
- **C2 Interface / MDCS**
- **C2 and Communications Layers**
- **Impact of critical Weather Conditions**
- **New Hostile Autonomous Threats (e.g. AUV)**
- **Dual Use / General Purpose**
- **Simulation of Civilians: not only a Port**

- **Injecting simulated events in the real exercise***
- **Feeding Simulation *Online* with real data from* Exercise**
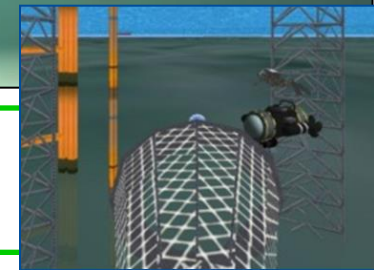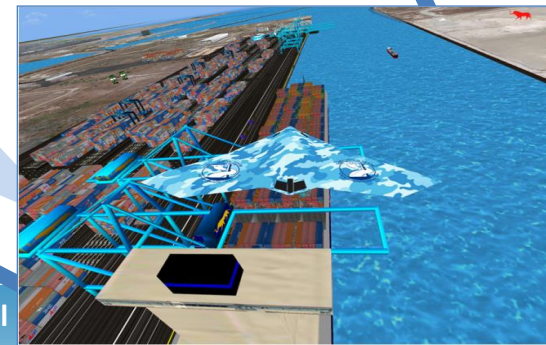
# Table Top Scenario & M2SG

Open Sea
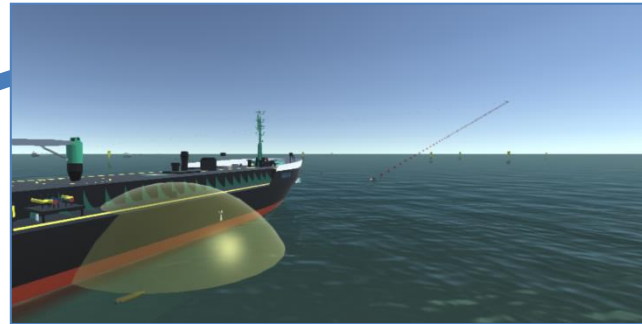
**Coast Shallow waters**
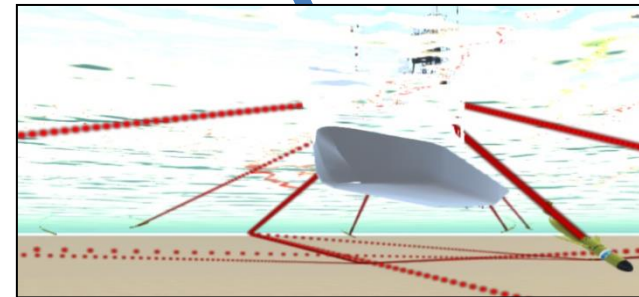
Port

- **Potential use of M&S for PARC to support Table Top Exercise**

Defence and Homeland Security Scenario in Marine Domain

This Scenario is addressing security and defence including Port Protection and Critical Infrastructure Protection based on the use of Autonomous Underwater Vehicles (AUV) that interoperate in different ways (e.g. recharging, data downloading, payload upgrades, coordinated task execution). AUV, UAV, USV (Unmanned Surface Vehicles) and Docking Devices could interact in this framework
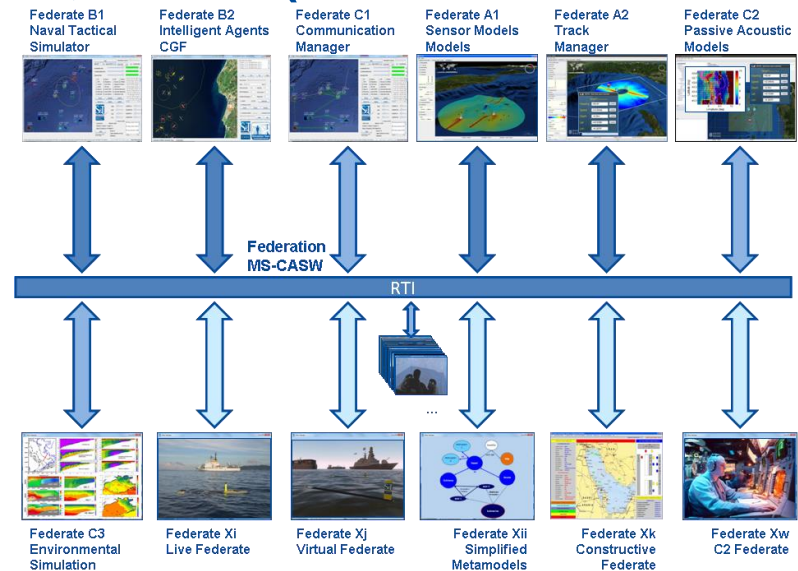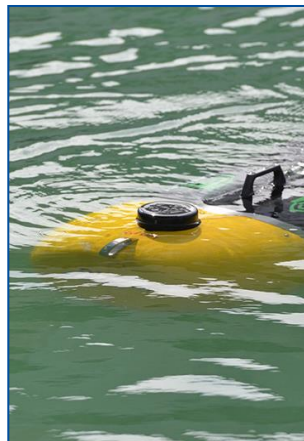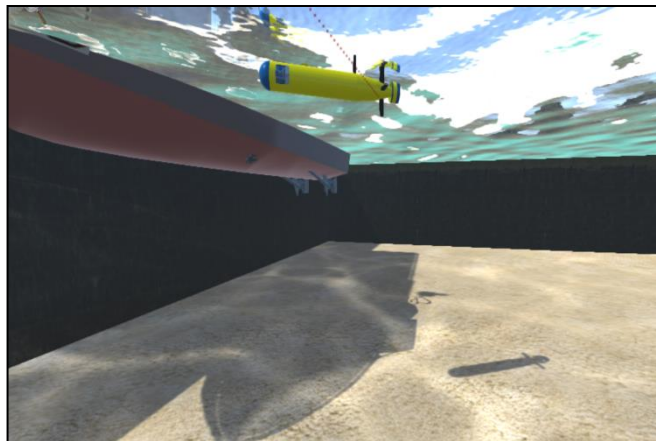
Collaboration at Sea…   and in Virtual Worlds

Virtual

Real
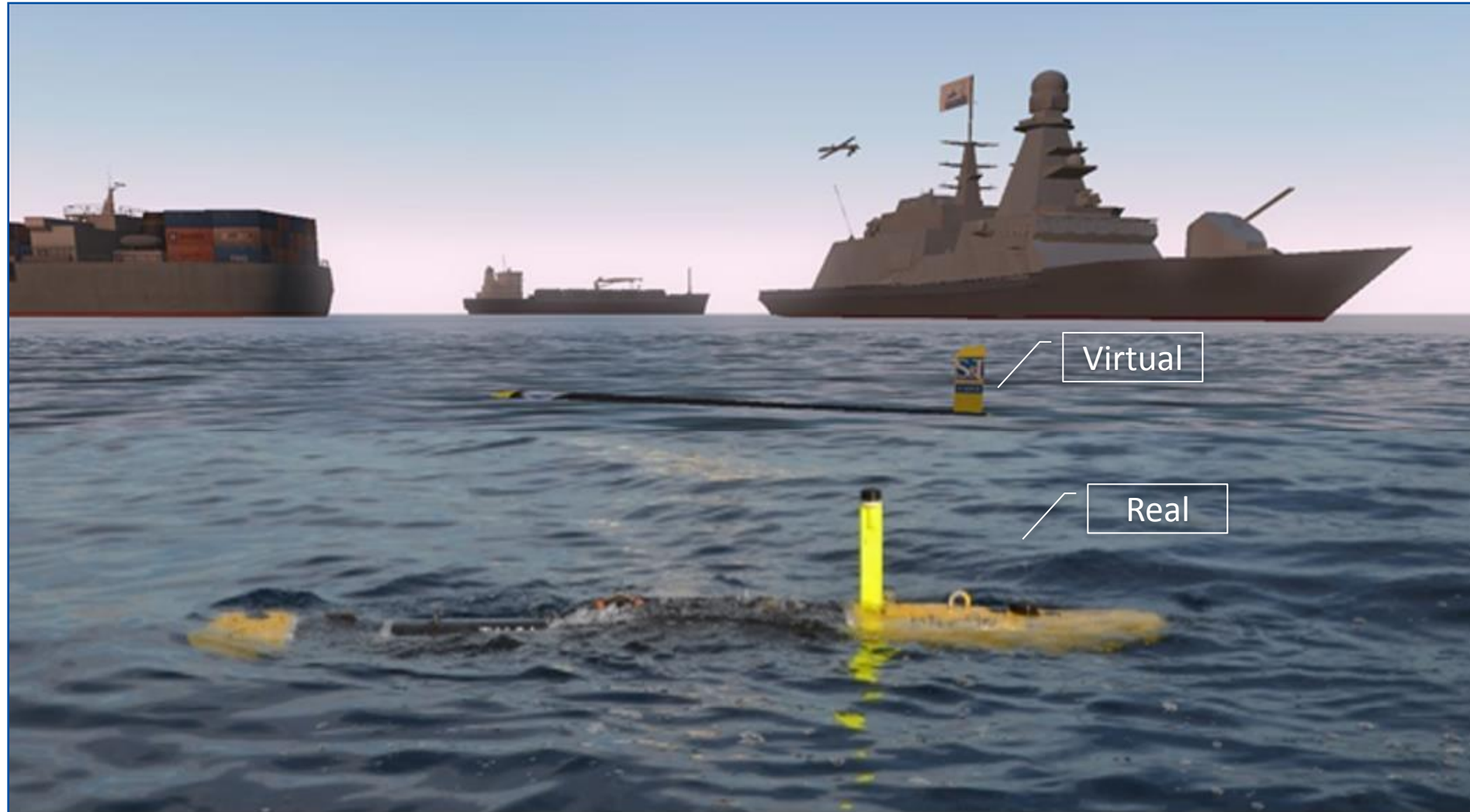
M&S Standards for New Capabilities

The Aim of this Research is to address the standards to be adopted in Modeling & Simulation to support development of new Capabilities based on use of Autonomous Systems

The research focused on the adoption of High Level Architecture (HLA), robot Operating System (ROS), and Data Distribution Service (DDS).

PARC Objectives & C-IED Capabilities

- **To identify the Architecture and Standards for interoperable distributed simulation of Autonomous Systems over Extended Maritime Framework supporting PARC (Persistent Autonomous Reconfigurable Capability) programme**
- **To Develop Test Bed Capability fo Autonomous Systems by using Modelling and Simulation (M&S) before going to sea.**
- **To Develop new Scenarios to Study different Concepts of Interoperability among Autonomous Systems by M&S.**
- **To Develop Joint Innovative researches related to the use of M&S applied to Autonomous Systems by a multidisciplinary team of NATO STO CMRE, Simulation Team and Genoa University for enhancing models, federations, standards**
- **To increase autonomy, persistence and reliability of Autonomous Systems operating over EMF**

EMF Extended Maritime Framework

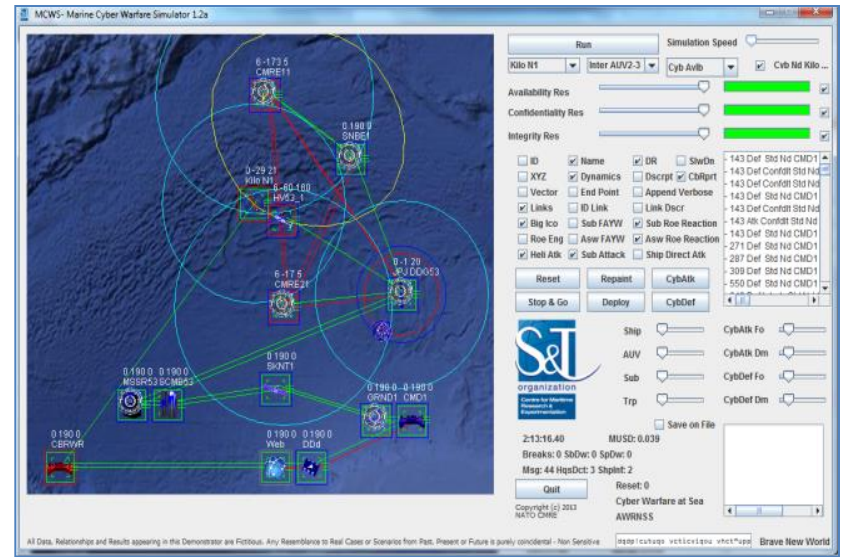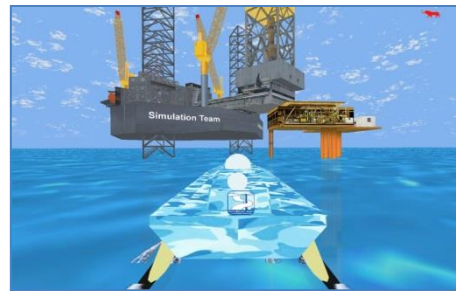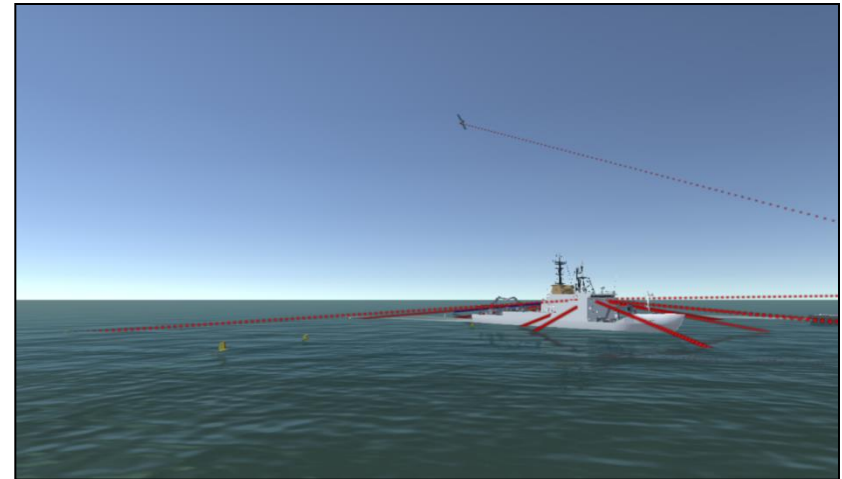# Extended Maritime Framework and UAS

Unmanned Autonomous Systems (UAS) are present over all the Different Domains; Drones and Unmanned Autonomous Systems are becoming popular in many areas interacting with legacy systems and their capabilities are improving in terms of Functionalities, Operational Issues, Autonomy. Due to the complexity of mission environments, the specific UAS characteristics and associated heterogeneous networks, the use of Modeling and Simulation (M&S) to support research and development in this field is crucial.`

Coast, Underwater, Surface, Air, Cyber, Space

Investigation and Testing of Innovative Autonomous Systems

New generation of Autonomous Systems are expected to get strong benefits from their operational interoperability with other systems. The interoperability and standardization procedures need to be defined through experimentation in virtual environment. M&S addresses specific issues related to training on future scenarios, as well as on capability assessments.

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PARC & M&S for Surveillance

PARC (*Persistent Autonomous Reconfigurable Capability*) programme focuses on autonomous system interoperability within the extended maritime framework.

M&S, in PARC, addresses the identification of proper mix for simulation in this context in terms of distributed interoperable simulation framework, architecture and standards (simulation, robotics, C2, etc)

The current focus is mainly on :

- **HLA (High level Architecture) and its integration with ROS (Robotic Operating System) environment.**
- **Creation of a federation supporting HIL and SIL (HW and SW in the loop) within synthetic environments to address operational contexts**
- **Simulation of Man in the Loop (e.g. Man directly controlling assets) as well as Man on the Loop (e.g. Human Supervision as-signing high level tasks to Autonomous Systems).**
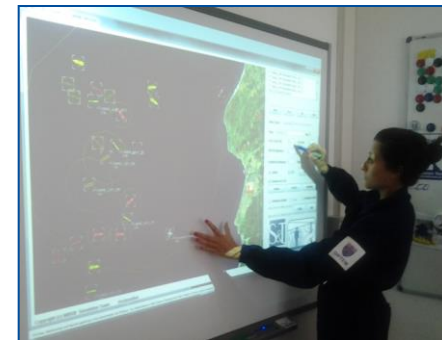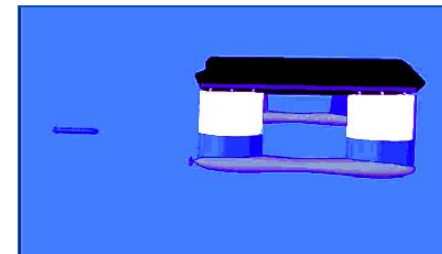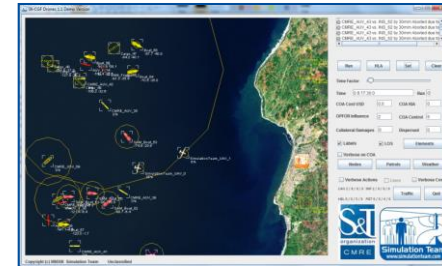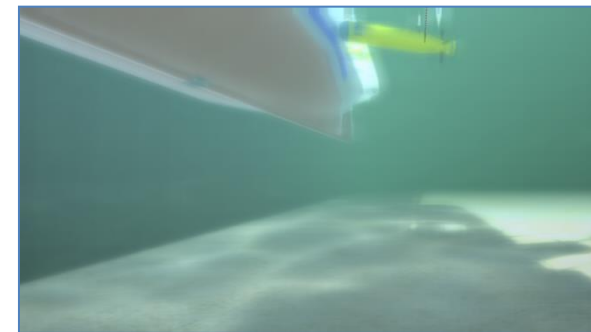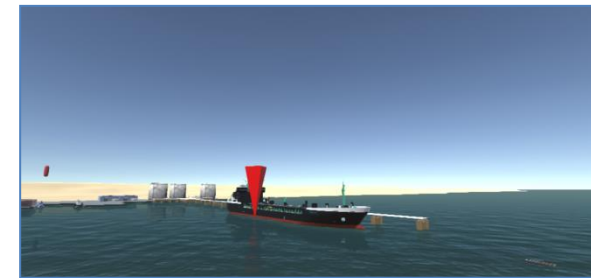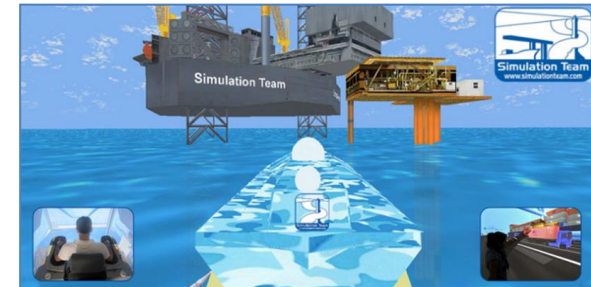
Collaborative Behaviors among UAS

UAS ability to interoperate each other and with legacy systems is a new frontier able to overtake the limitations single systems.

It is important to simulate multiple AxSs (Autonomous multi domain Systems) and different platforms.

The scope is to test UAS effectiveness in collaborative assignments as well as in competitive roles.
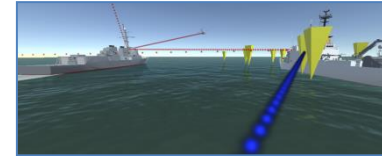

Single UAS | Multiple UAS | Different UAS | Joint Collaboration | Full Collaboration

UUV

USV

UAV

UGV
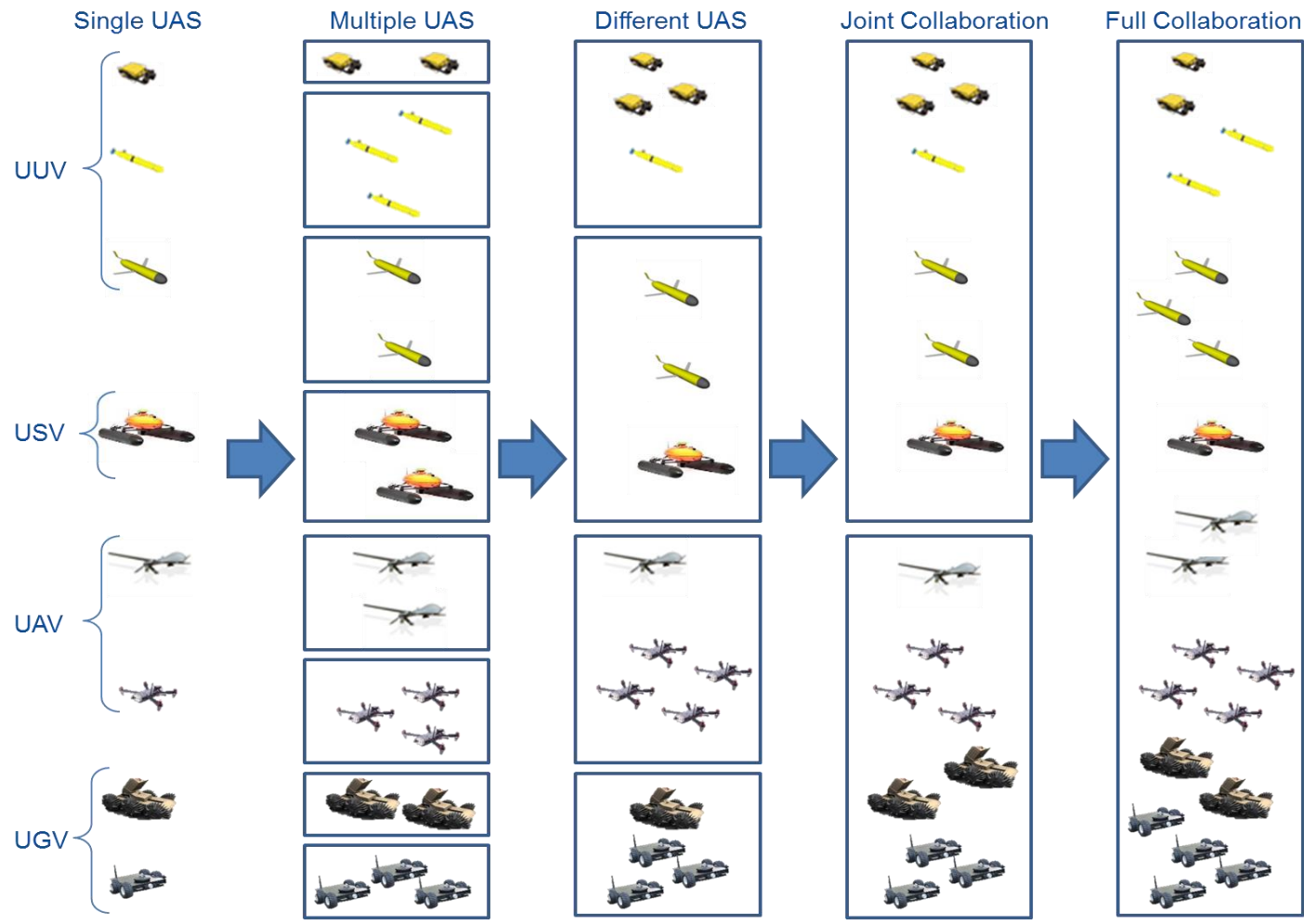
Improving Real Capabilities by M&S

Improvement of existing standards and development of new ones for interoperability are crucial elements to move up interoperability to complex scenarios and to improve operational use of new solutions.
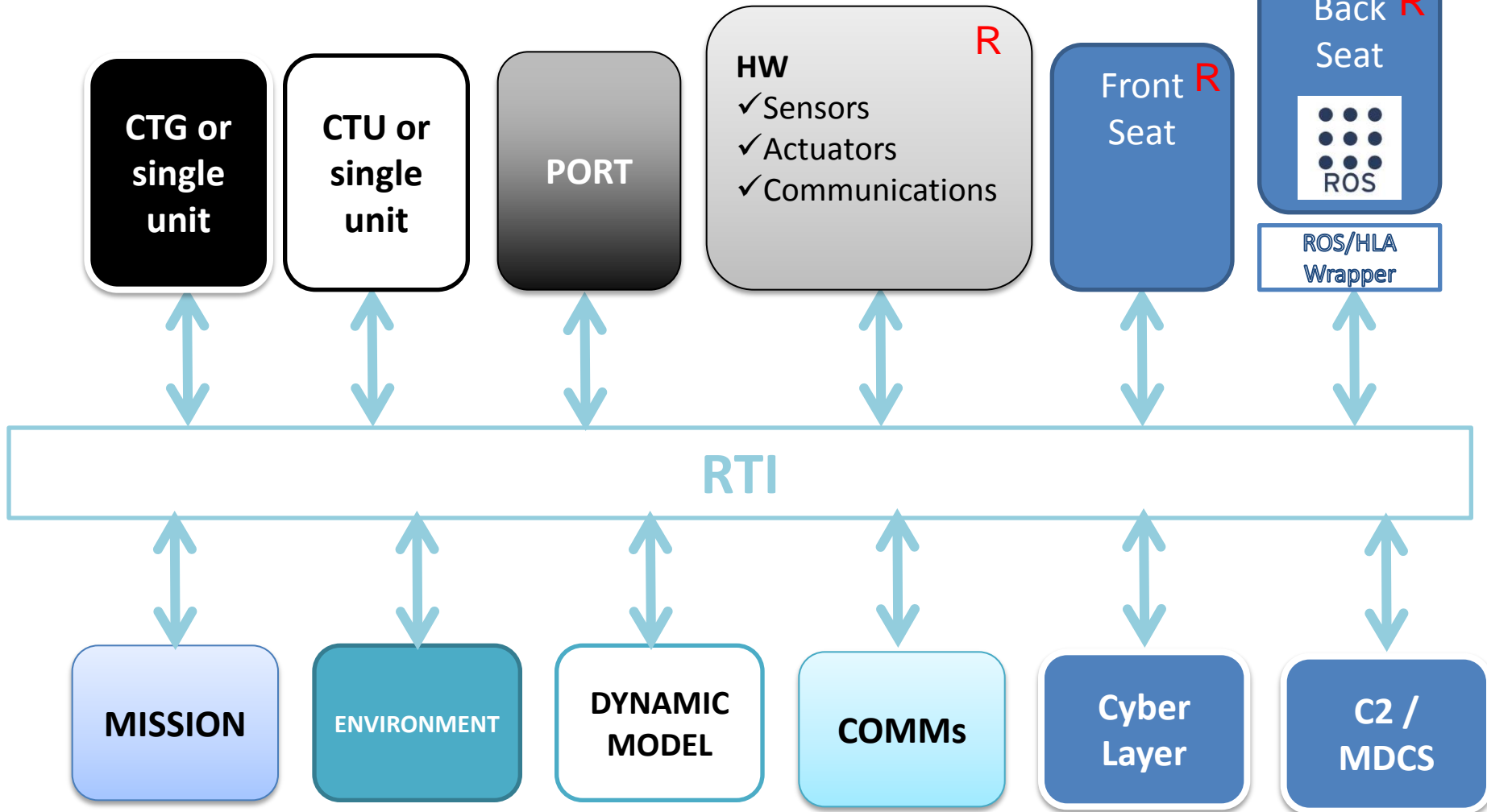
Real and simulated elements including communication and C2 layers (Command and Control) in different mission environments need models. All these systems address the necessity to create heterogeneous networks among Autonomous Systems combining several elements within complex environments. To proceed we are working on scenario for critical infrastructure and port protection.

Example of Federation

R: real assets

CTG or single unit

CTU or single unit

PORT

HW R
✓Sensors
✓Actuators
✓Communications

Front Seat R

Back Seat R

ROS

ROS/HLA Wrapper

RTI

MISSION

ENVIRONMENT

DYNAMIC MODEL

COMMs

Cyber Layer

C2 / MDCS

Conclusions

M&S could support Counter-IED at sea by supporting :

- *Education, Training and Crowdsourcing on C-IED by Modeling, Interoperable Simulation and Serious Games (MS2G)*
- *Development of new Autonomous Systems as Interoperable Assets in the Extended Maritime Framework for C-IED*
- *Development of New Concepts and Solutions by Virtual Interoperable Testing (e.g. persistence, autonomy, reliability)*
- *Evaluation of New Strategic Scenarios including new threats (e.g. Autonomous Hostile Devices)*

Each of these elements represents a great opportunity supported by the skills and capabilities within the Partnership CMRE. Simulation Team, University of Genoa, NATO COE able to use M&S for Research and Experimentation in a wide spectrum of applications.

Questions?

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