OCEAN2020 ACHIEVEMENTS

OCEAN2020 Closing Conference
Brussels, 27th of October 2021

Contents

OCEAN2020

- **OCEAN2020 Overall Project** - **Antonino Arecchi,** Project Coordinator
- **Mediterranean Sea Demonstration** - **Antonino Arecchi,** Leonardo
- **Baltic Sea Demonstration** - **Ingrid Leijonhufvud,** Saab
- **EU Maritime Operation Center** - **Fernando Barbero,** Indra
- **Technology Development and System Simulation** - **Wilmuth Mueller,** IOSB
- **EU-NATO Interoperability** - **Yan Pailhas,** CMRE
- **Human Factor** - **Tomasz Bajer,** CTM
- **Leading to the Future** - **Olivier Reichert,** Safran

OCEAN2020 ACHIEVEMENTS OVERALL PROJECT

OCEAN2020 Closing Conference
Bruxelles, 27th of October 2021

OCEAN2020 Project Objectives

- **Operational objectives** √
  - Significant improvement of **maritime Situation Awareness** through the integration of **UXS** (Unmanned Systems) with **ISTAR** (Intelligence Surveillance Target Acquisition and Reconnaissance) payload capabilities
  - **Interoperability** by use of open architecture and recognised standards

- **Technical objectives** √
  - **High integration among EU countries and heterogeneous systems**, demonstrated in full-scale live trials
    - *Mediterranean Sea demonstration in 2019*
    - *Baltic Sea demonstration in 2021*

    > The first multi-national demonstrations simultaneously involving UAV, RUAV, USV, AUV, ROV

  - Development of EU C4ISR **open architecture**
  - Integration of EU/NATO/civil **data framework**
  - Advanced **data and information fusion** techniques for shorter decision time at **CMS** (Combat Management System) and **MOC** (Maritime Operations Centre) levels
  - Increased **autonomy** for UXS, swarm operations, cooperation of assets
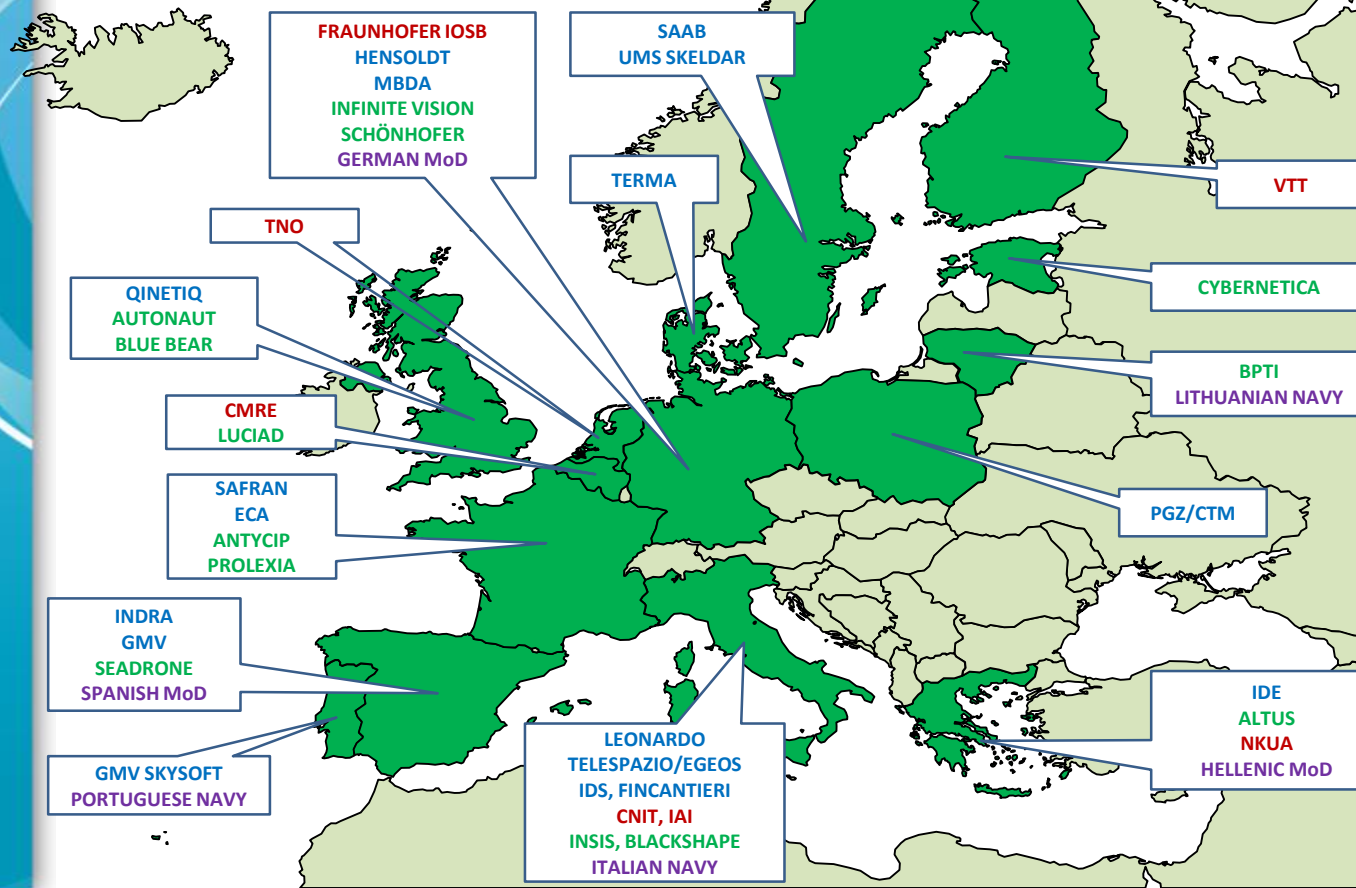
- **Cooperation objectives** √
  - Diverse EU wide consortium to demonstrate large military R&T effort
  - Improve market position of European defence industry in UXSInvolve End-Users in design choices
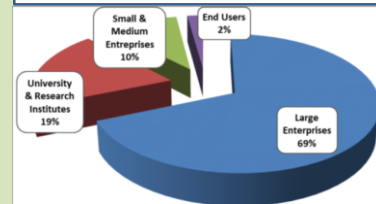
Expected impact :
- **demonstrate the potential of EU-funded research for defense applications**
- **boost the European industrial capacity in the military unmanned systems market** √
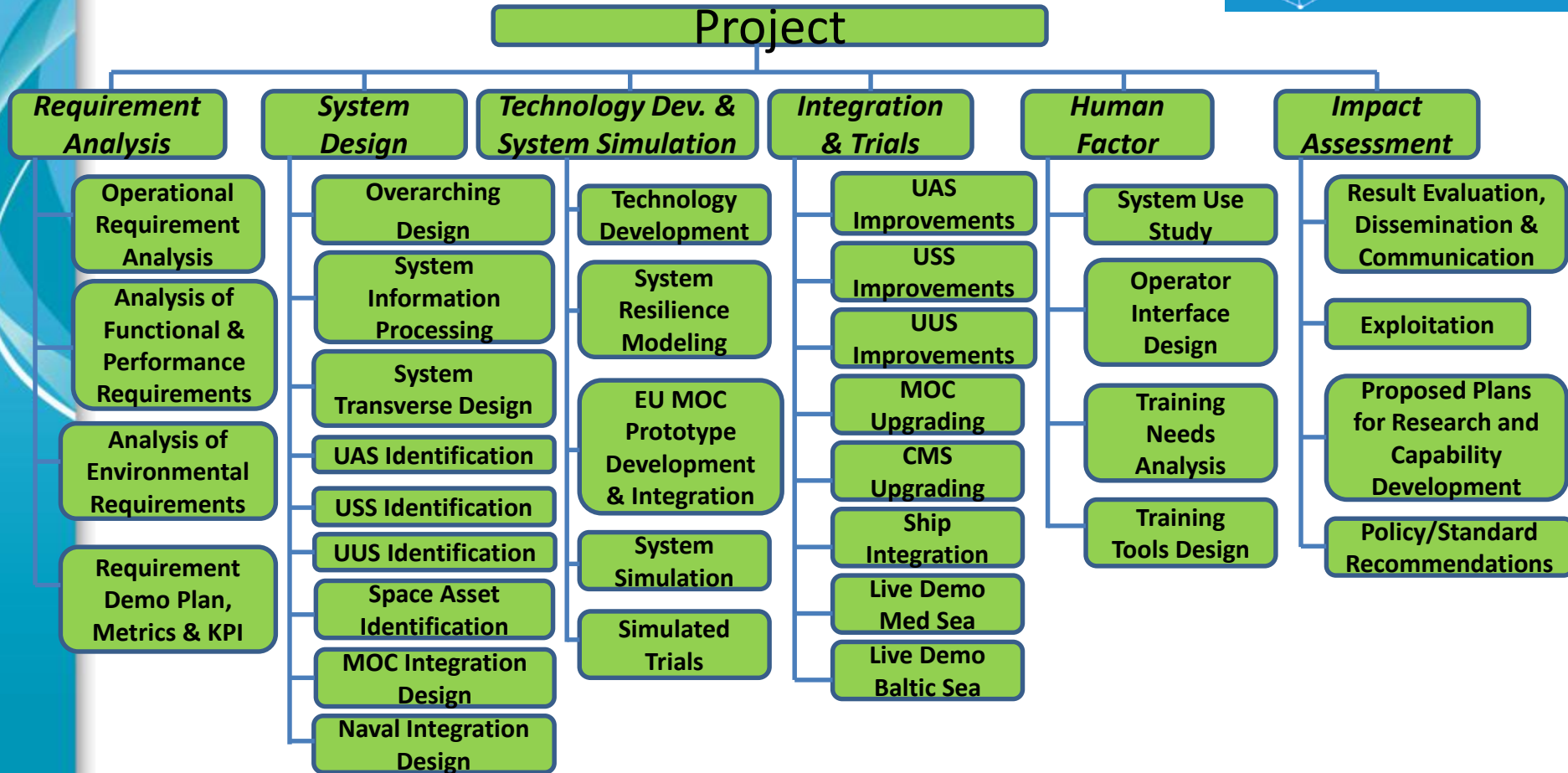
OCEAN2020 Consortium

➤ *15 nations*   ➤ *43 partners*

OCEAN2020

LARGE ENTERPRISE
SMALL/MEDIUM ENTERPRISE
RESEARCH INSTITUTE
END USER

FRAUNHOFER IOSB
HENSOLDT
MBDA
INFINITE VISION
SCHÖNHOFER
GERMAN MoD

SAAB
UMS SKELDAR

VTT

TERMA

CYBERNETICA

TNO

QINETIQ
AUTONAUT
BLUE BEAR

BPTI
LITHUANIAN NAVY

CMRE
LUCIAD

SAFRAN
ECA
ANTYCIP
PROLEXIA

PGZ/CTM

INDRA
GMV
SEADRONE
SPANISH MoD

IDE
ALTUS
NKUA
HELLENIC MoD

GMV SKYSOFT
PORTUGUESE NAVY

LEONARDO
TELESPAZIO/EGEOS
IDS, FINCANTIERI
CNIT, IAI
INSIS, BLACKSHAPE
ITALIAN NAVY

Work Breakdown Structure

OCEAN2020

```
                              Project
```

Requirement Analysis
- Operational Requirement Analysis
- Analysis of Functional & Performance Requirements
- Analysis of Environmental Requirements
- Requirement Demo Plan, Metrics & KPI

System Design
- Overarching Design
- System Information Processing
- System Transverse Design
- UAS Identification
- USS Identification
- UUS Identification
- Space Asset Identification
- MOC Integration Design
- Naval Integration Design

Technology Dev. & System Simulation
- Technology Development
- System Resilience Modeling
- EU MOC Prototype Development & Integration
- System Simulation
- Simulated Trials

Integration & Trials
- UAS Improvements
- USS Improvements
- UUS Improvements
- MOC Upgrading
- CMS Upgrading
- Ship Integration
- Live Demo Med Sea
- Live Demo Baltic Sea

Human Factor
- System Use Study
- Operator Interface Design
- Training Needs Analysis
- Training Tools Design

Impact Assessment
- Result Evaluation, Dissemination & Communication
- Exploitation
- Proposed Plans for Research and Capability Development
- Policy/Standard Recommendations

Project Metrics

OCEAN2020 logo

OCEAN2020: the PADR Project with highest budget (35.5 M€ out of 90 M€ of PADR Budget)

Timeline:
- **Project Kick-off** — April 2018
- **System Requirements Review** — October 2018
- **System Design Review** — May 2019
- **Demo 1 Med Sea** — November 2019
- **Simulated Trial 1** — January 2020
- COVID-19 outbreak
- **Simulated Trials 2 & 3** — February & March 2021
- **Demo 2 Baltic Sea** — August 2021
- **Final Review** — October 2021
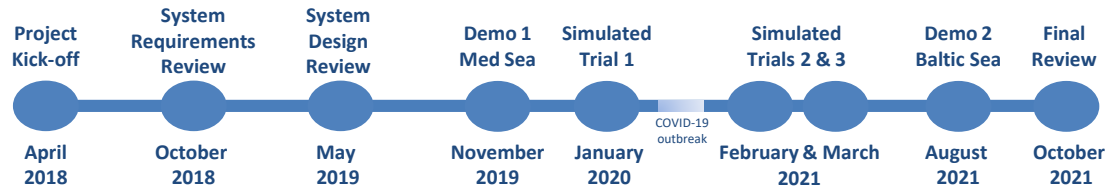
10 National MoDs/Navies supporting OCEAN2020
- *Italian Navy*
- *Hellenic Navy*
- *Spanish Navy*
- *Portuguese Navy*
- *Lithuanian Navy*
- *German MoD*
- *Swedish Navy*
- *French Navy*
- *Polish Navy*
- *Royal Dutch Navy*

- Huge number of highly skilled people involved: around **3600** Man-months
- Huge number of deliverables: **363 Deliverable Items**, More than **220 Delivery Notes**
- Extensive Reviews: **1 Requirement Review, 4 Design Reviews, 5 Trial Readiness Reviews, 5 Trial Result Reviews**
- **3 Simulated Trials**
- **2 Live Trials at Sea** (including **5 planning conferences for each Trial**)
- Deep Involvement of End Users
  - WG Meetings for Requirement Analysis and Human Factors, Workshop for System Architecture and Communication, Trial Planning Conferences
- Significant Dissemination Efforts
  - **4** Webinars, **25** Project Presentations, an average of **800** visits/month of Project Website (more than **14.000** visits in the latest **16** months), **193** posts on Twitter with **559** followers and **57** posts on LinkedIn with **585** followers in the latest **16** months

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MEDITERRANEAN SEA DEMONSTRATION

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OCEAN2020 Mediterranean Sea Live Demo

20 - 21 November 2019

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NAVAL UNITS

Italian Frigate 1 (Martinengo, FREMM)

Italian Frigate 2 (Fasan, FREMM)

Spanish Frigate (Santa Maria)

Hellenic Frigate (Limnos)

French AOR (Var, Durance class)

Italian MTC (Gorgona Class) - *suspect vessel*

MANNED AIRCRAFT

Italian NH90 Helicopter

LOCATIONS:

AREA OF OPERATIONS:

Gulf of Taranto: SEA AREA

Taranto: NAVAL BASE (Italian Navy)

Grottaglie: MILITARY AIRPORT

MARITIME OPERATION CENTRES:

Bruxelles (EDA): EU MOC prototype

Rome: Italian MOC

Cartagena: Spanish MOC

Athens: Hellenic MOC

Lisbon: Portuguese MOC

UAV UNMANNED AIR VEHICLES

LEONARDO AW Hero

LEONARDO SW-4 Solo

INDRA Pelícano

BLACKSHAPE Bk180-ISP

USV UNMANNED SURFACE VEHICLES

ECA Inspector

IDE SeaRider

SEADRONE SEAD-23

UUV UNMANNED UNDERWATER VEHICLES

ECA AUV A9

ECA ROV Seascan

OCEAN2020 Mediterranean Sea Live Demo
Data Distribution Architecture
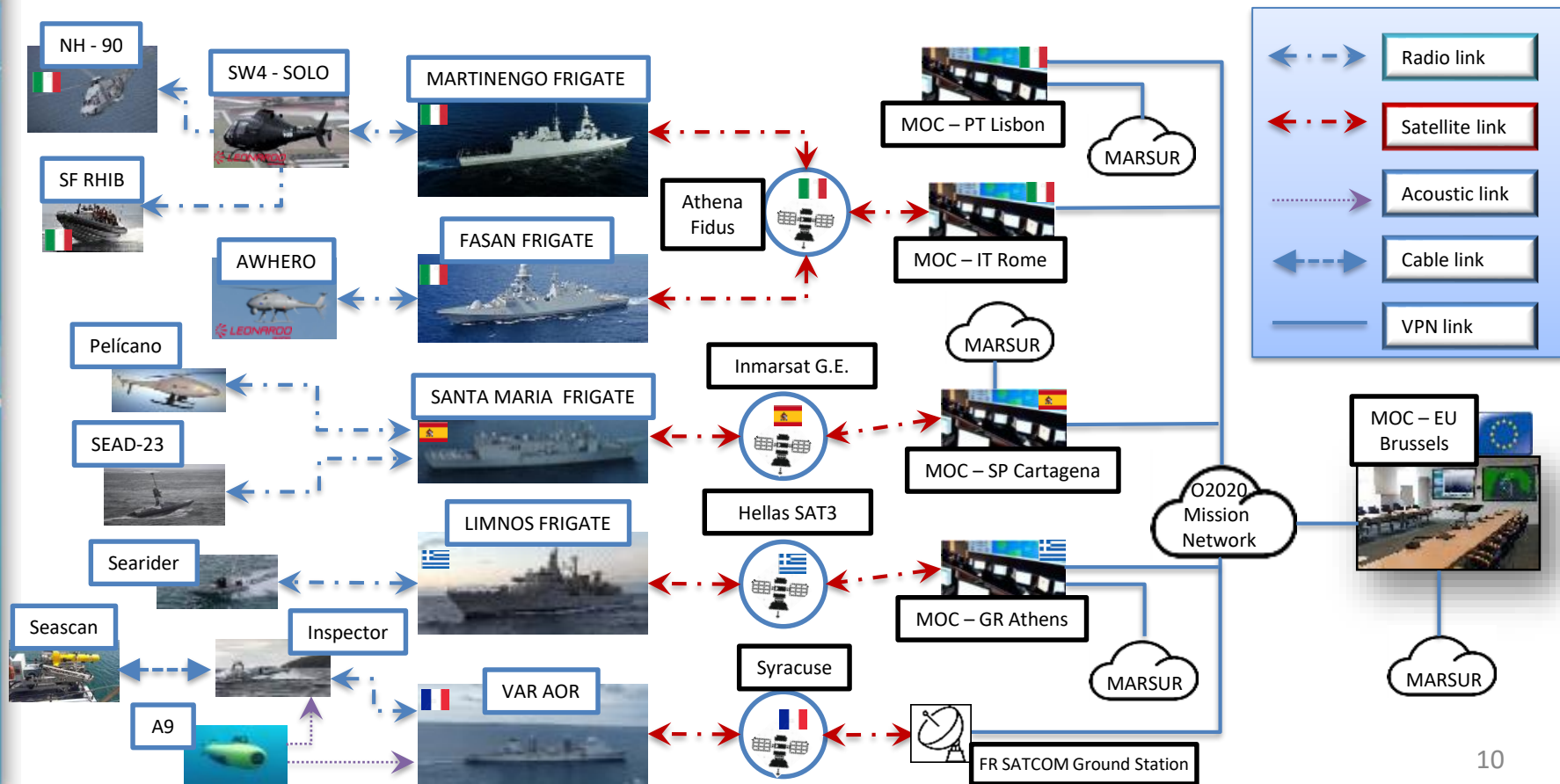
OCEAN2020 Med Sea Demo – Scenario #1

Threatening Vessel Interdiction

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Phase 0 Scenario preparation / Persistent Surveillance

Cosmo Sky Med (Earth Observation Satellite)

Phase 1 Alert for anomaly detection

Cosmo Sky Med (Earth Observation Satellite)

Phase 2 Resource tasking and area search

BK180-ISP

Phase 3 Localisation, classification and identification

SEAD 23

SEARIDER

AW HERO

SW-4 SOLO

Phase 4 Surface engagement *(simulated)*

INSPECTOR

SW-4 SOLO

Phase 5 UW localisation of the threat remains

A9 AUV

INSPECTOR

SEASCAN - ROV

OCEAN2020 Med Sea Demo – Scenario #2

Mine Laying Vessel Interception before an Amphibious Operation

Phase 0 Scenario preparation / Intelligence received

Phase 1 Suspect vessel leaves the harbour and is detected by USV and UAV

Phase 2 Covert localisation and tracking with UAV

Phase 3 Mines are released by the suspect vessel

Phase 4 Vessel boarding by RHIB with UAV and manned Helo support (Manned-Unmanned Teaming)

Phase 5 Mines localisation and identification with UUV

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BALTIC SEA DEMONSTRATION

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OCEAN2020 Baltic Sea Demo

25 - 26 August 2021

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NAVAL UNITS

Lithuanian Patrol Vessel (P11 Žemaitis)
German Research Ship (R/V Planet)
Swedish Vessel (HMS Pelikanen)
Polish Minehunter (ORP CZAJKA)
Swedish Patrol Boats (CB90) - *suspect vessel*

MANNED AIRCRAFT

HENSOLDT MASTER
(B200 Super King Air)

UAV UNMANNED AIR VEHICLES

LEONARDO SW-4 Solo
SAFRAN Patroller
BLUE BEAR Cobra

LOCATIONS:

AREA OF OPERATIONS:

Hanö Bight: SEA AREA

Ravlunda Firing Range: Land Test Centre including CTG

Kristianstad Airport: AIRPORT

MARITIME OPERATION CENTRE:

Brussels (EDA): EU MOC prototype

USV UNMANNED SURFACE VEHICLES

TNO Searaider

IOSB Water Strider

SAAB Enforcer III

SAAB Piraya

AUTONAUT AN5.4 Jura (UK demo)

UUV UNMANNED UNDERWATER VEHICLES

IOSB DeDave
TNO Oceanscan
SAAB Sea Wasp
CMRE BIONDo
GMV SKYSOFT Gavia
SAAB AUV-62 - *suspect submarine*

Baltic Sea Demo **Data Distribution Architecture**

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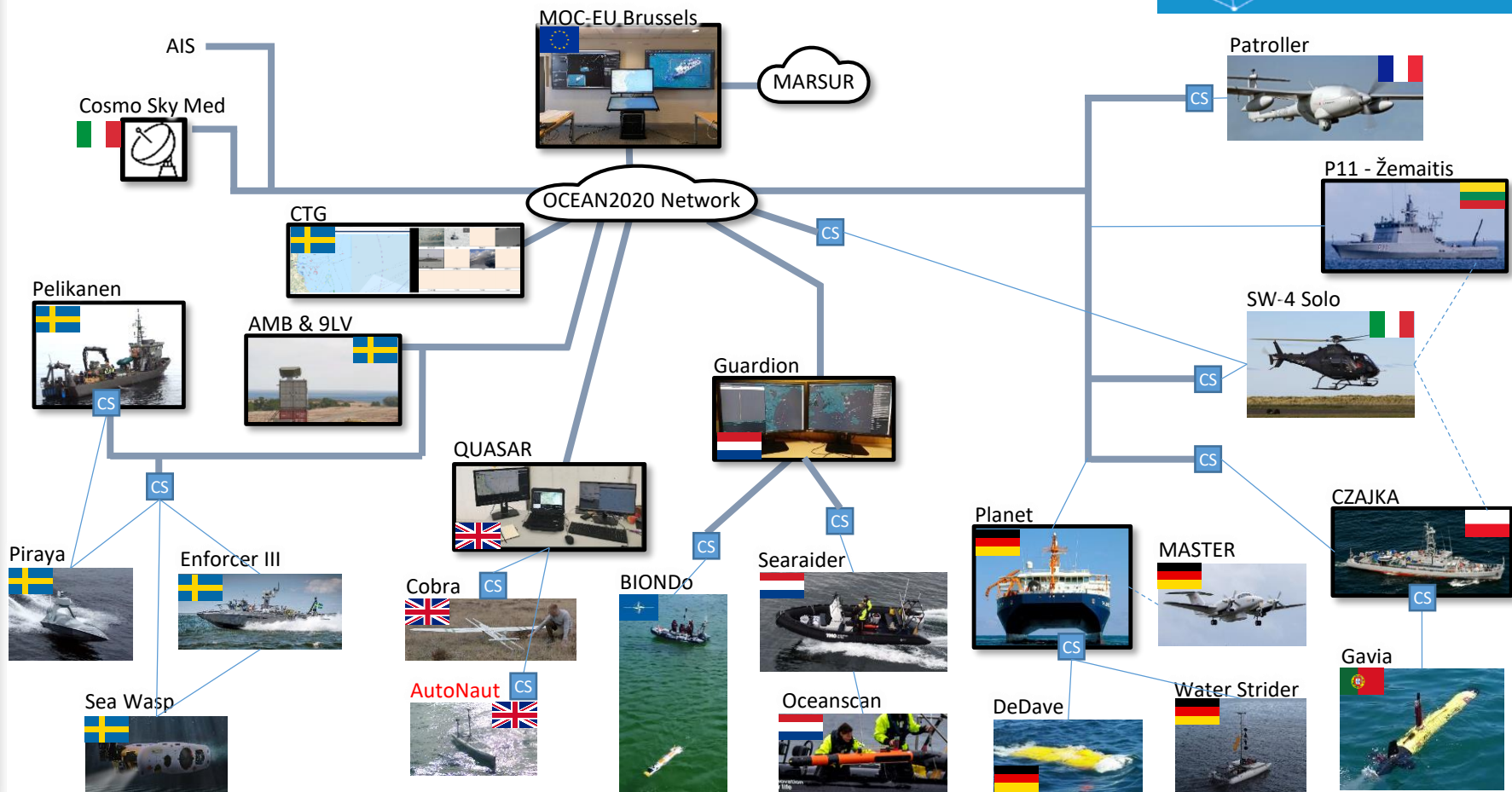
Baltic Sea Demo – Scenario #3
High Speed threat

Phase 0 Scenario preparation / Persistent Surveillance

Phase 1 Alert for anomaly detection

Phase 2 Resource tasking and Area Search

Phase 3 Localisation, Classification and Identification

Phase 4 Engagement (simulated)

Phase 5 Alert for anomaly detection of new threat

Phase 6 Resource Tasking and Area Search

Phase 7 Localisation, Classification and Identification

Phase 8 Engagement (SOF boarding of ship and simulated)

Phase 9 UW survey of sunken ship
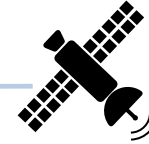
Cosmo Sky Med
(Earth Observation Satellite)

Piraya

Enforcer III

Patroller

AutoNaut

Water Strider

SW-4 Solo

Cobra

Sea Wasp

Baltic Sea Demo – Scenario #4
Unknown submerged activity

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Phase 0 Scenario preparation / Persistent Surveillance

AutoNaut

Phase 1 Suspect submarine detected

Phase 2 Resource tasking and Area Search

Patroller   SW-4 Solo   Cobra

Phase 3 Localisation, Classification and Identification

Gavia   DeDave

BIONDo   Searaider   Enforcer III

Oceanscan   Sea Wasp

Phase 4 Destroy mine (simulated)

OCEAN2020 ACHIEVEMENTS
EU MARITIME OPERATION CENTER

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EU MOC Concept

- The prototype of a European Union Maritime Operations Centre (EU MOC) has been designed to provide a demonstrator of data integration and operational facilities enabling the commanders' situational awareness.

- The EU MOC has been equipped as a decision center and has taken active part in the demonstrations, receiving information from ships at sea and land-based systems (including data and videos from Unmanned Systems), providing a Recognized Maritime Picture (RMP), and exploiting decision support tools.

- The EU MOC has been deployed in the EDA facilities in Brussels.

EU MOC based on OCEAN2020 Target Architectures

Baltic Demonstration

Mediterranean Demonstration

EU MOC Physical Deployments at EDA
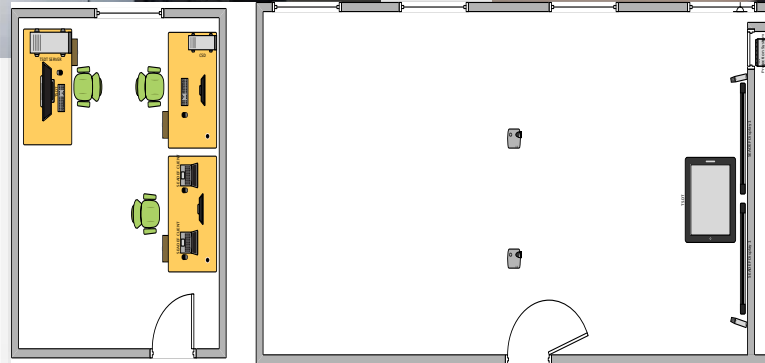
November 2019 – Mediterranean Scenarios

August 2021 – Baltic Scenarios
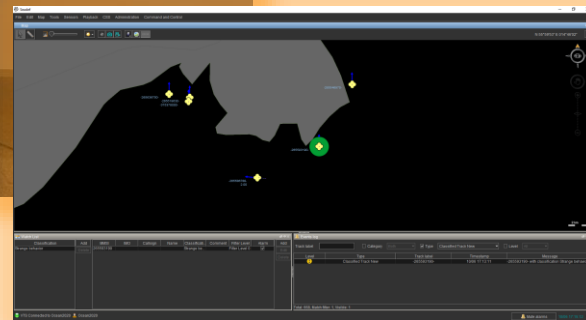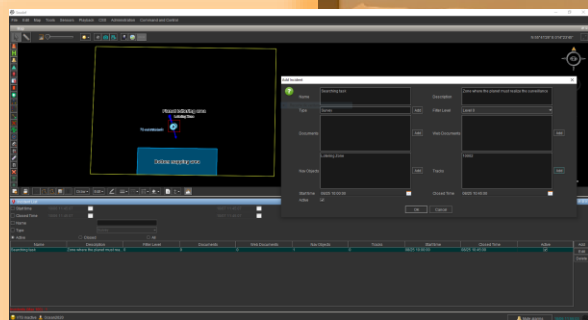
Overall assessment of EU MOC Prototype

- Main endevour's **objectives achieved**:

  - High integration among EU countries and heterogeneous systems, demonstrated in two full scale-demos
  - Increase situation awareness in naval operations
  - Integration of video and data from unmanned systems
  - Increase interoperability through the exploitation and sharing of real time information

- The excellent **collaboration** among partners and with the End Users was a key factor, and allowed the correct execution of the EU MOC functionality
- The solid **communication architecture** and **system integration** allowed to transmit and show at EU MOC level the information provided by the assets

  Blueprint of future EU MOC has been designed, deployed and shown in operational environments

Achievements and future trends

New visualization techniques

Automation of surveillance operation

Operator functions related to information and communication security

Data fusion algorithms

Integration with existing networks - MARSUR

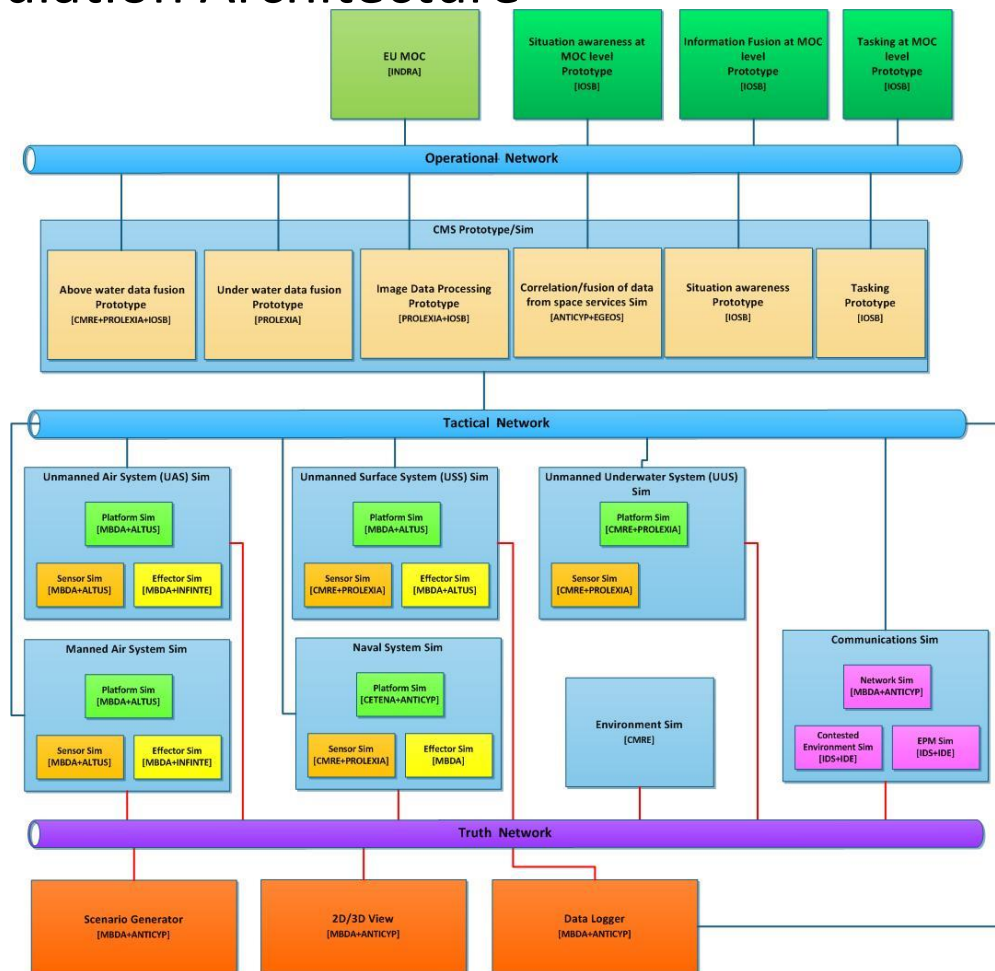# Technology Development

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- Technology Development - Prototypes
  - Data Fusion Prototype
    - Above Water Data Fusion
    - Under Water Data Fusion
    - Satellite Data Correlation and Fusion
  - Video Processing Prototype
    - EO and IR image enhancement algorithms
    - Vessel detection and classification algorithms
  - Situation Awareness Prototype
    - Data integration into RMP
    - Situation assessment and Situational Prediction
  - UxS Deployment, UxS Swarming Prototypes
    - Autonomous UAV
    - UAS / USS / UUS Swarming Behaviour
    - Modelling of flexible sensor suite
  - UAS Future Radar Prototype
    - Detection of small maritime targets from high grazing angles
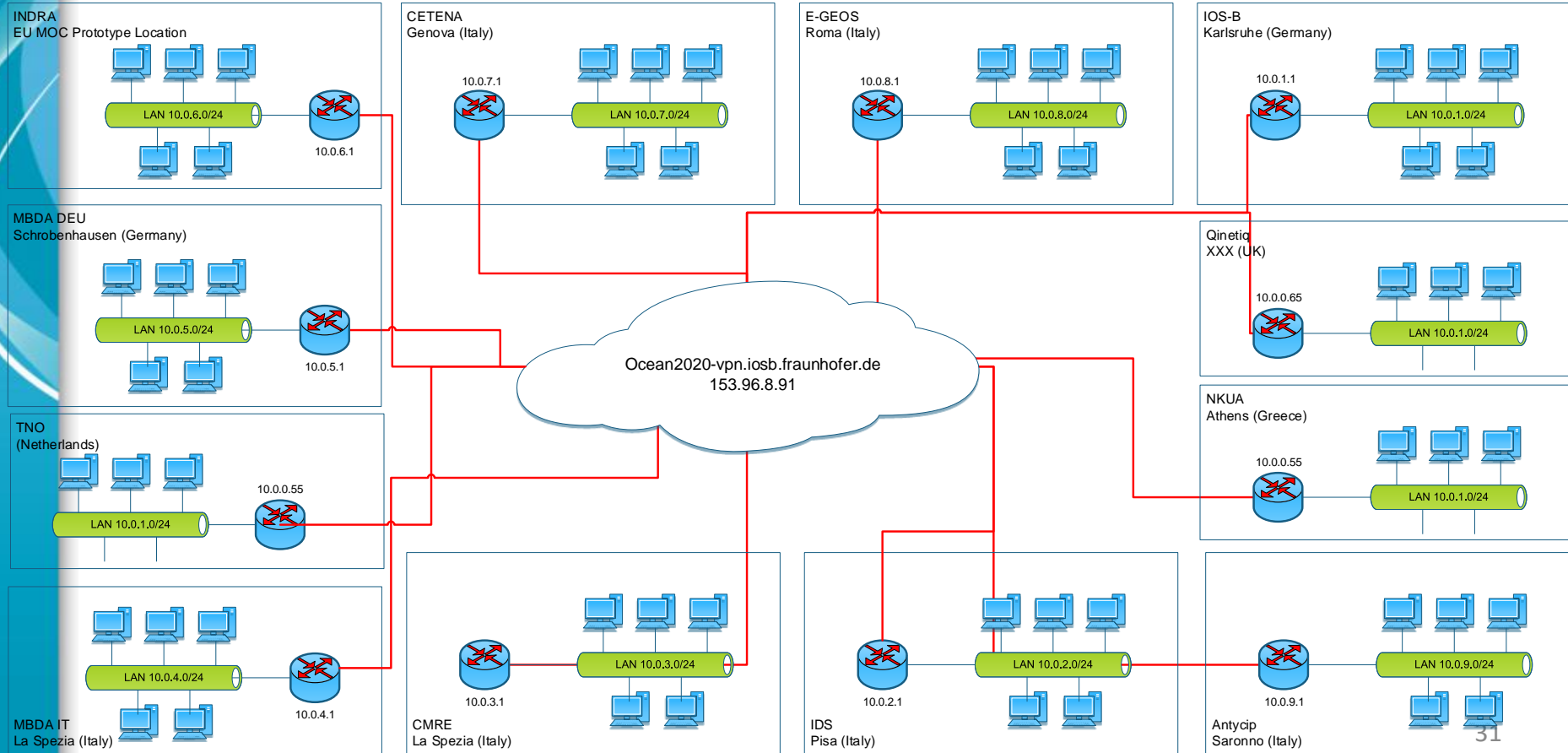 - EU MOC Prototype

System Simulation and Simulated Trials

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- ## System Resilience Modelling
  - Environmental Condition Modelling
  - Communication and Electromagnetic Modelling
- ## System Simulation
  - Distributed Simulation Infrastructure
  - Simulation of Operational Scenarios
  - Integration of all Simulators into one Simulation
  - → Simulated Trials

System Simulation and Simulated Trials

- ## Simulated Trials
  - ### 3 Simulated Trials
    - January 2020 – Replay of Med Sea Live Trial Scenarios
    - February 2021 – Pre-play of Baltic Live Trial Scenarios
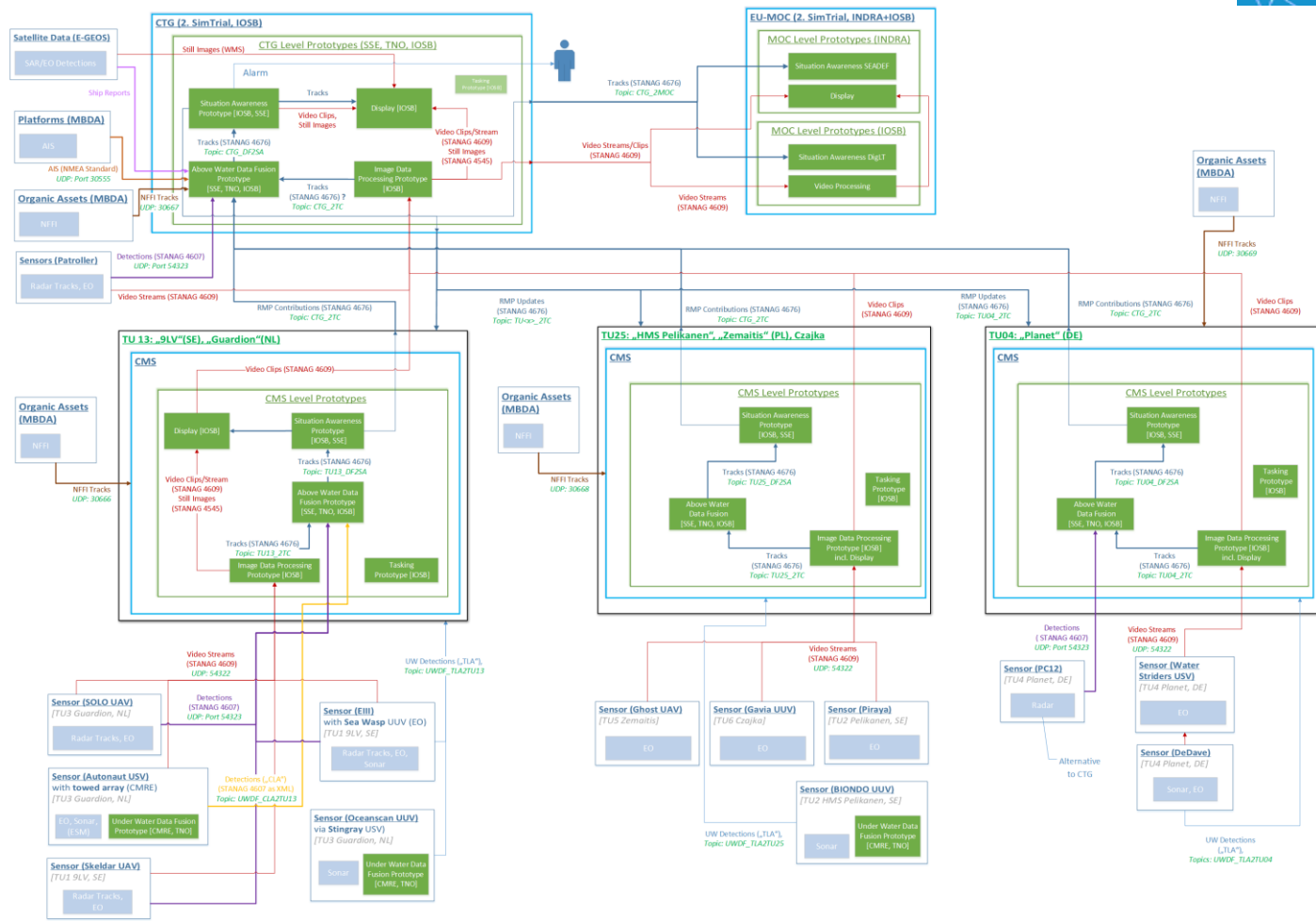   - March 2021 – Enhanced Baltic Live Trial Scenario and additional vignettes

# Simulation Architecture

Simulation Architecture – Remote Labs

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INDRA
EU MOC Prototype Location
LAN 10.0.6.0/24
10.0.6.1

CETENA
Genova (Italy)
10.0.7.1
LAN 10.0.7.0/24

E-GEOS
Roma (Italy)
10.0.8.1
LAN 10.0.8.0/24

IOS-B
Karlsruhe (Germany)
10.0.1.1
LAN 10.0.1.0/24

MBDA DEU
Schrobenhausen (Germany)
LAN 10.0.5.0/24
10.0.5.1

Qinetiq
XXX (UK)
10.0.0.65
LAN 10.0.1.0/24

TNO
(Netherlands)
10.0.0.55
LAN 10.0.1.0/24

Ocean2020-vpn.iosb.fraunhofer.de
153.96.8.91

NKUA
Athens (Greece)
10.0.0.55
LAN 10.0.1.0/24

MBDA IT
La Spezia (Italy)
LAN 10.0.4.0/24
10.0.4.1

CMRE
La Spezia (Italy)
10.0.3.1
LAN 10.0.3.0/24

IDS
Pisa (Italy)
10.0.2.1
LAN 10.0.2.0/24

Antycip
Saronno (Italy)
10.0.9.1
LAN 10.0.9.0/24

31

Simulated Trial - ORBAT

Simulated Trial – Execution – Screen Shots

EU MOC Prototype

Overview of involved asstes
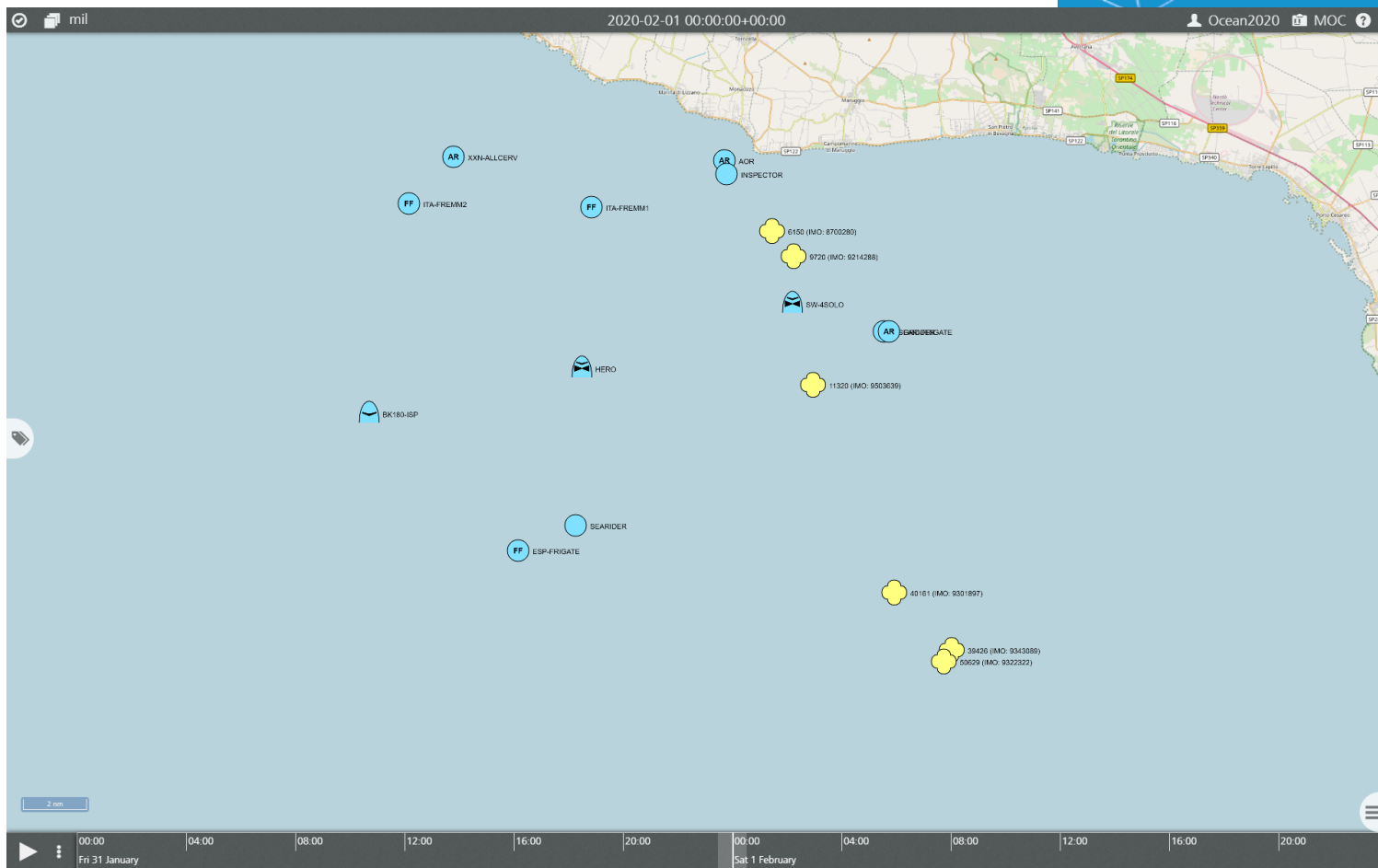
OCEAN2020 ACHIEVEMENTS EU-NATO INTEROPERABILITY

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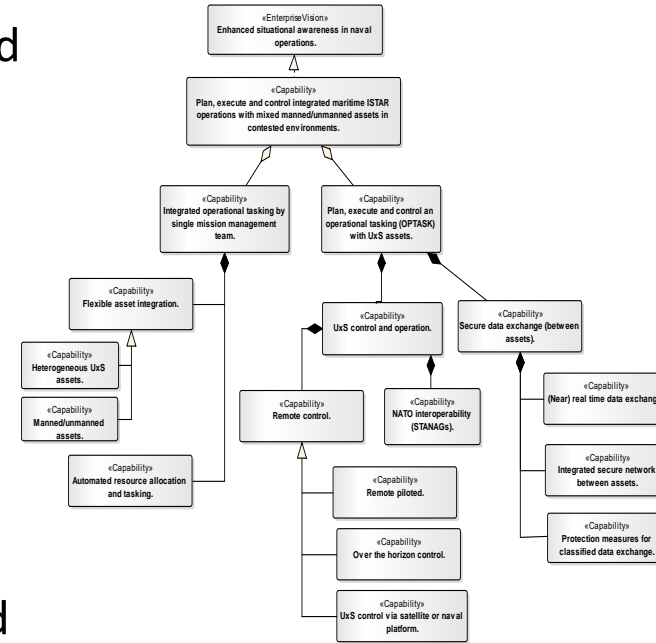# EU-NATO Interoperability – Rationale

NATO Interoperability

"The ability to act together coherently, effectively and efficiently to achieve Allied objectives."

"Interoperability is essential to ensure of NATO's forces effectiveness." SACT, Gen. Palomeros, 2013

EU-NATO

Achieving EU-NATO interoperability is one of the innovation objectives of OCEAN2020.

Lessons learnt from previous projects (ex: MAJIIC) promoting NATO ISTAR interoperability through the usage and refinement of existing NATO standards and process descriptions.

Key takeaway: **Federated, standards-based approaches are flexible and effective.**

EU-NATO Interoperability – Execution

Within OCEAN2020's simulation activities, EU-NATO interoperability was applied in two main areas:

- **STANAG 4603 (High Level Architecture) used to manage the data exchange between federates**

    - Specialist simulators, or federates, from multiple simulation providers were combined to generate a common ground truth .

- **NATO Standards (*Inc. STANAGs 4609, 4607, 4676 and NFFI*) used to connect the unmanned systems to the CMS systems both in simulated and live trials**

    - Enabling to support and de-risk development, testing and training of higher level technologies.
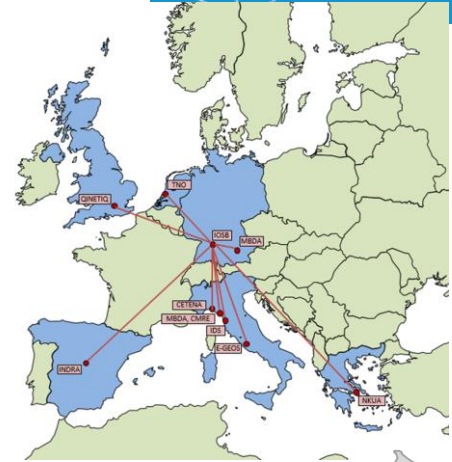
Key takeaway: **Standardised interfaces allowed all partners to contribute to a single, distributed, persistent and representative development and test environment.**

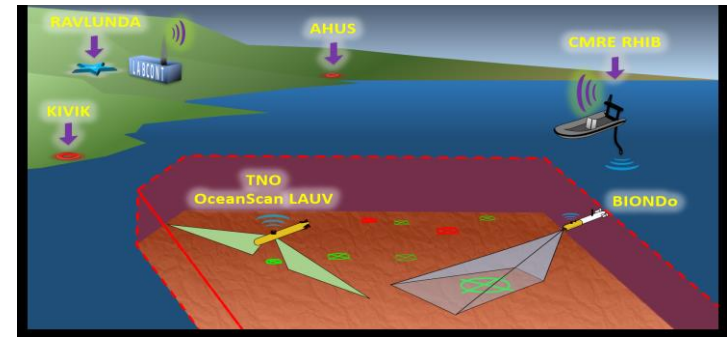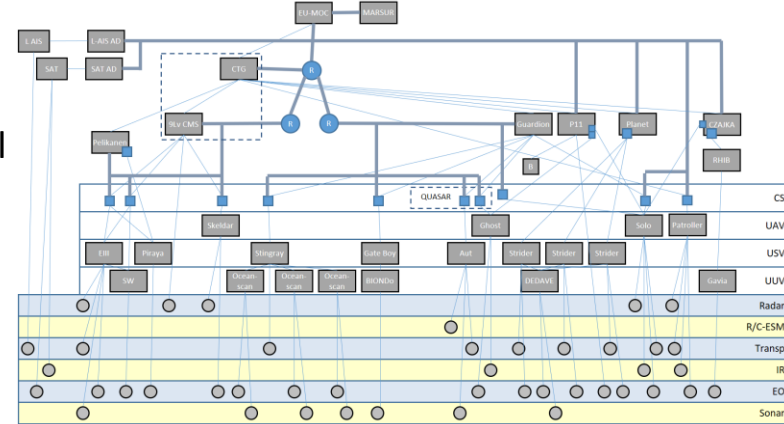# EU-NATO Interoperability – Execution

Live Sea Demonstrations

Wide range of EU-NATO interoperability capabilities: from operational planning with mixed manned and unmanned assets (including STANAG-4586) to the control of a single vehicle.

STANAG-based flows during live sea demonstrations include 4545 (Imagery), 4559 (ISR interface), 4609 (electro-optical/infrared video), 4607 (radar detection), 4676 (radar track data) and NFFI.

## NATO standards as technology enabler

- – Widespread dependency on existing standards to jump-start integration
- – Between assets, between MOCs, between CMS
- – Usage of prototype approaches
  - • EU contributing to NATO efforts by validating and using NATO standard
  - • Possibly MARSUR used by NATO

Key takeaway: **OCEAN2020 addresses a broad range of interoperability capabilities**

EU-NATO Interoperability – Future

- Interoperability greatly reduces overall integration costs

- But many gaps for true federated UxS operations in realistic scenarios

  - Generic tasking for UxS (see SCI-288/SCI-343)

  - Network- and mission-aware protocols distribution of ISR data

  - Opportunity for EU projects to share significant role in way forward

Opportunity!

xxxx

4817

4586

4607

4609

STANAGs

existing   proposed   to identify
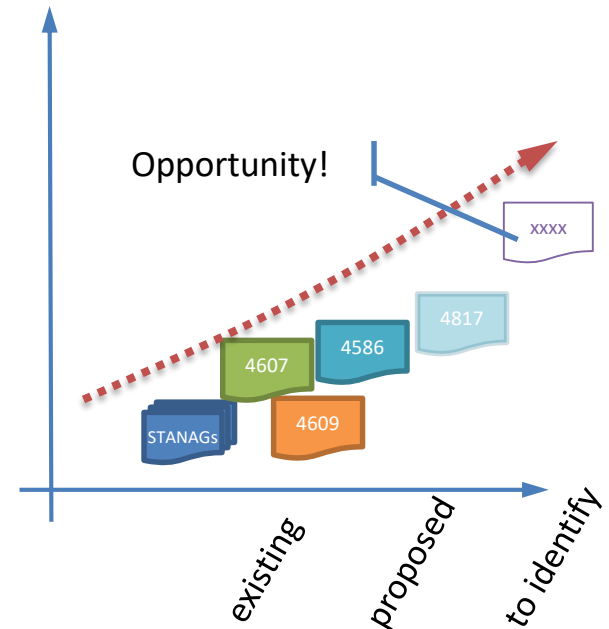
OCEAN2020 ACHIEVEMENTS
HUMAN FACTOR

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Human Factor - Achievements

BASIS – OPERATOR INTERFACE - HMI

➤ *UXS – Unmanned (Air or Surface or Underwater) System*

➤ *CMS – Combat Management System*

➤ *MOC – Maritime Operation Centre*

Two main areas for the elaboration:

➤ *Requirements analysis*

➤ *Design*

ID	System Requirement	Design Elements
		Figure 72
2	As a Targeting Officer I would like to visualize the HVTL.	6.3.2.1.1.4
		Figure 74
3	As a Targeting Officer I would like to select a candidate target.	6.3.2.1.1.2
		Figure 72
		6.3.2.1.1.4
		Figure 74
4	As a Targeting Officer I would like to visualize the intelligence products associated to the candidate target.	6.3.2.1.1.2
		Figure 72
	er I would like to propose to assign/modify a target.	6.3.2.1.1.4
		Figure 74
	er I would like to insert/modify candidate	6.3.2.1.1.2
	er I would like to prop the HVTL.	
	er I would like to sele	
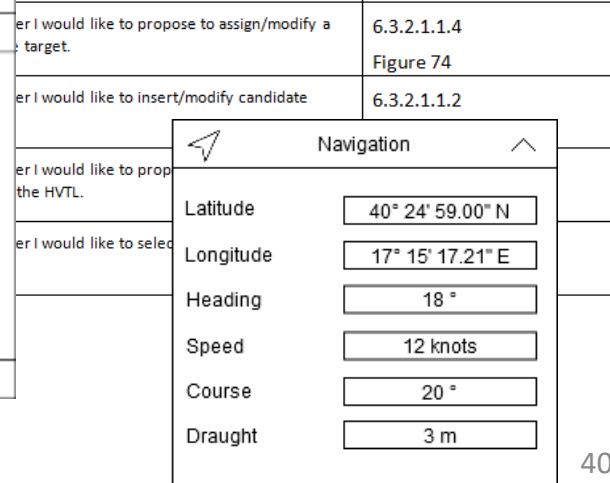
Human Factor - Achievements

Requirements analysis*:*

➢ *Roles – 35*

➢ *Duties - 80*

➢ *Tasks – 167*

Training Needs Analysis*:*

➢ *Planning and Supervision;*

➢ *Surveillance*

➢ *Identification and recognition*

➢ *Target Acquisition and Interdiction*
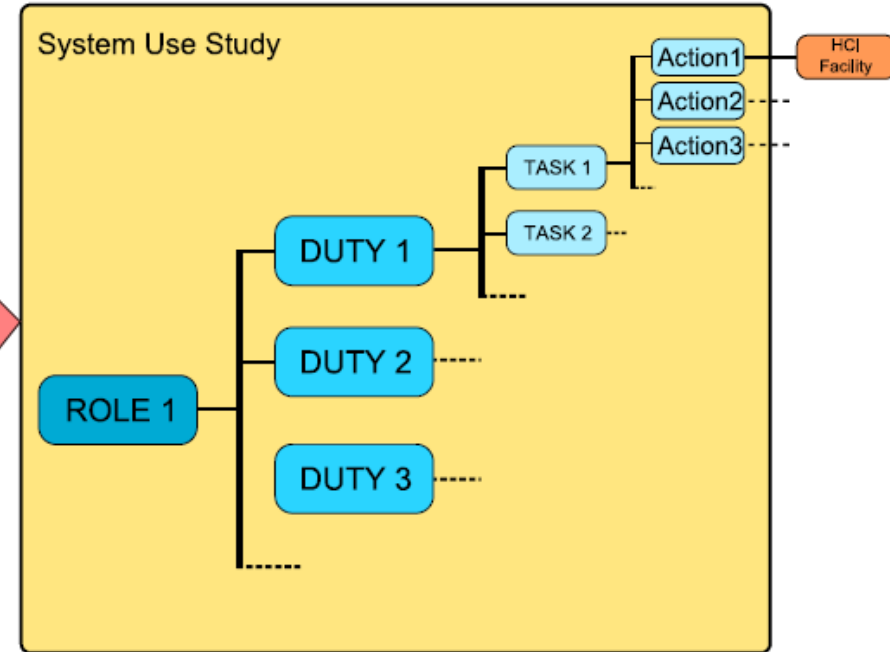
Human Factor - Achievements

Operator Interface Design – Leave control to the User

➢ *GUI solutions; control devices; ergonomic approach*

➢ *Unmanned Systems functionality*

➢ *SWARM functionality*

➢ *AR and VR tools – possibilities for the adaptation*

➢ *Assimilation of the new improvements – against the habits*
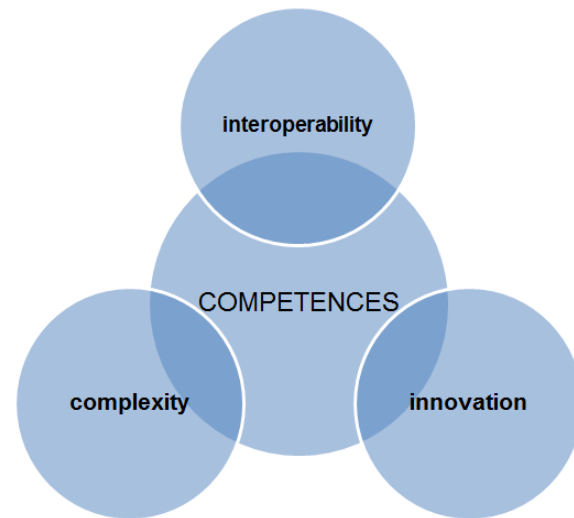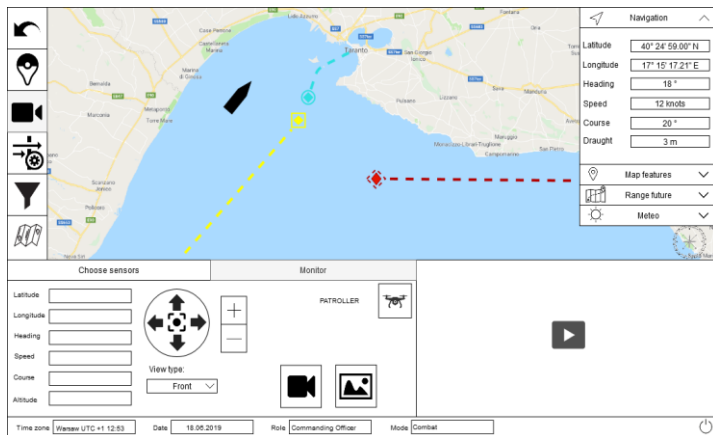
Training Tools Design

➢ *Training process – general assumption*

➢ *Training tools – the reality of the environment*

➢ *Operator evaluation process*

➢ *Maritime Training Centre concept*

Human Factor - Achievements

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Conclusions:

- Extraordinary cooperation between entities involved in certain tasks and activities
- All deliverables provided according Main Project Schedule (notwithstanding Covid-19 limitations)
- Presentation of technical and functional requirements toward to next generation interfaces (incl. Unmanned systems capabilities)
- Presentation of AR and VR tools/technology for the adaptation within maritime domain
- Strong cooperation with End-Users to provide the expected results regarding operator interfaces

OCEAN2020 ACHIEVEMENTS LEADING TO THE FUTURE

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Short term (<2024) Research Roadmap

Main research domains identified by OCEAN2020 :

- Data Processing
  - **Fusion algorithms** for improved situation awareness using a network of manned and unmanned systems
  - Sonar data processing, sonar imagery exploitation
- Behaviour
  - **Collaborative autonomy and combined operations of UxVs, squads and swarms**
  - Robust platform navigation and timing solution (in a GPS denied environment)
- Communication
  - **Resilient communication between autonomous vehicles**
  - Increasing the use of Software-defined Wide Area Network
- Command & Control
  - **Automated mission and task management** for heterogeneous, multi-domain UxVs, squads and swarms

Short term (<2024) Capability Development Roadmap

Main capabilities development domains identified by OCEAN2020:

- UxS Platform
  - Development of **Detect and Avoid (DAA) solution**
  - **Integration of new SATCOM** to platforms
  - Real-time (self-)diagnostics, health monitoring and fault prognostics
- UxS Sensors processing
  - Sensors **data fusion**
  - **Improved radar sea decluttering**
  - **Automatic classification** of ISAR image
- Communication
  - **Secure, wideband communication solutions** for UxS and MOC links
  - Increasing the use of Software-defined Wide Area Network
- Command & Control
  - **National MOCs** and Maritime Security Systems **using the UxS solutions**
  - First integration of **secure network** between participating **MOCs and UxSs**

Main OCEAN2020 capabilities to improve based on lessons learned

OCEAN2020

Data processing

- Improved video compression limiting bandwidth use
- Data & information fusion & track geolocation: multisensor, multisource, multiscale…
- Artificial Intelligence for decision support, for situational awareness improvement and situation prediction

Communication

- Communication management issue solving
- Onboard SATCOM use
- Underwater mesh network

UxS

Operation with low visibility / high sea state

Small UAV swarm use

Increase autonomy behavior

CMS/CTG/MOC

Video manager role

Automatic alert on basis of video analysis

> *The identified improvements are in line with research and capability development roadmap*

Exploiting OCEAN2020 massive trial database

OCEAN2020

- Huge amount of operational data has been gathered during OCEAN2020 live trials
  - Sensor, platform, datalink, tasking, …
  - Multisensor, multiplatform, multidomain, timestamped data
- A must for improvement of multi-UxS-MOCs architecture capabilities (fusion, comm. management…)

> *Exploitation of OCEAN2020 data generated during the live demos could be the basis of a follow-on project on multi-UxS deployment*

Improved **sensor exploitation & fusion**

Autonomy

Innovative connectivity architecture / CMS integration / interoperability

Interoperability/integration of RMP at MOC level

Multiple collaborative UxS deployment (communication management, swarming)

Robustness to maritime environment (ex. USV deployment in high sea state)

OCEAN202**4**

Leveraging on OCEAN2020 to increase maturity of unmanned systems engaged in joint deployment

OCEAN202**4**

- 6 main R&D topics
- T0 2023
- 2 to 3 years depending on budget
- Analysis of connectivity architectures (mesh network…) based on end-user CONOPS
- Validation through simulations, lab demos (using real data from OCEAN2020) and a final live demonstration at sea
  - Scenarios involving UUV, USV & UAV : naval task group defense, submarine warfare, area interdiction, harbor/infrastructure protection
- Contractual framework : European Defense Fund
  - EDF Work Program 2022 leading to T0 in 2023
  - Alternative contractual framework : EDA ad'hoc B

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