OCEAN2020 Project

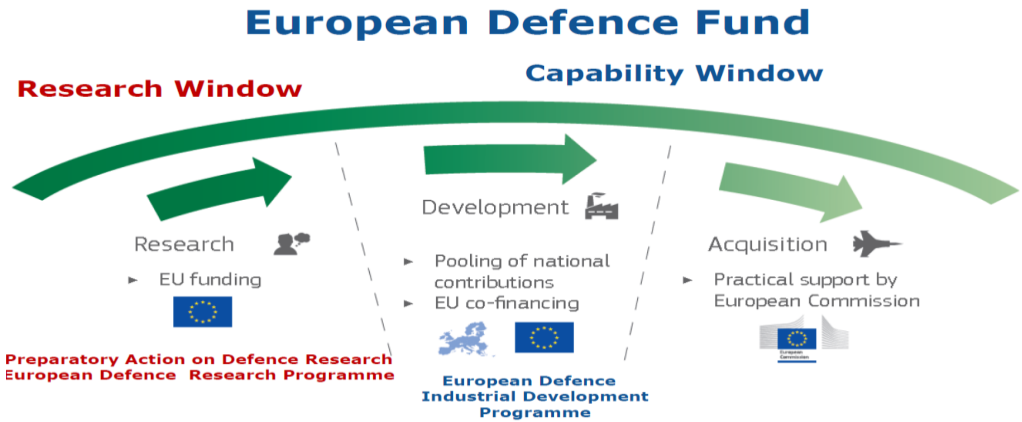
The Human Factor in Unmanned Systems Operations

24th June 2021

This project has received funding from the European Union's Preparatory Action on Defence Research under grant agreement No 801697

OCEAN2020 Project Context

- ***PADR*** *is the* ***1st step*** *of a* ***European Defense Research and Capability Development Programme***
- ***PADR*** *is launched and funded by the* ***European Commission***
- ***European Defense Agency*** *is the implementing agency for the PADR*



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

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*

OCEAN2020 Project Objectives

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- **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***
  - 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 UXS
  - Involve 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*

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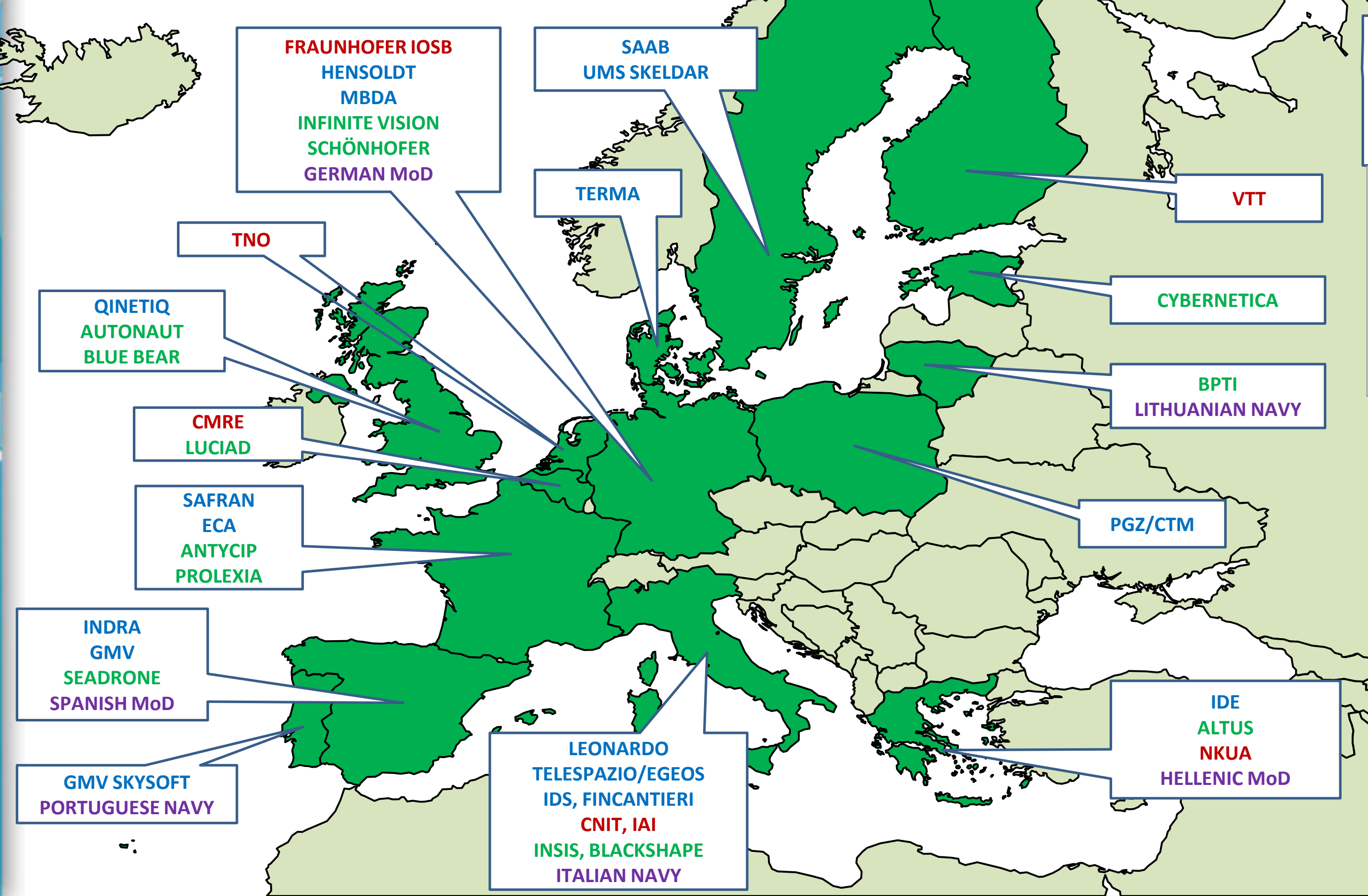

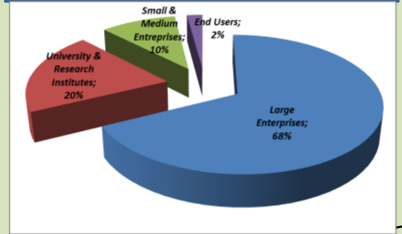

OCEAN2020 Work Breakdown Structure
Human Factor

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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 Info Processing
  - System Transverse Design
  - UAS Identification
  - USS Identification
  - UUS Identification
  - Space Asset Identification
  - MOC Integration Design
  - Naval Integration Design
- ***Tech.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 Planning for Reasarch & Capability Development
  - Policy/Standard Recommendations

Human Factor

Involvement of Consortium Partners

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Large Enterprises

CTM PGZ LEONARDO indra SAAB

IDE INTRACOM DEFENSE

ECA GROUP make sure

TERMA ALLIES IN INNOVATION

LUCIAD

Small and Medium Enterprises

BPTI BALTIC INSTITUTE OF ADVANCED TECHNOLOGY

ALTUS LSA

End Users

MARINA MILITARE

LIETUVOS KARO LAIVYNAS

Marinha

Human Factor Studies in OCEAN2020

Tomasz Bajer, CTM

HUMAN FACTOR - IDEA

Definition:

Human Factor *is the application of psychological and physiological principles to the (engineering and) design of products, processes, and systems.*

The goal of human factors is to reduce human error, increase productivity, enhance safety and comfort with a specific focus on the interaction between the human and the machine

HUMAN FACTOR – Analysis and Design Domains

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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

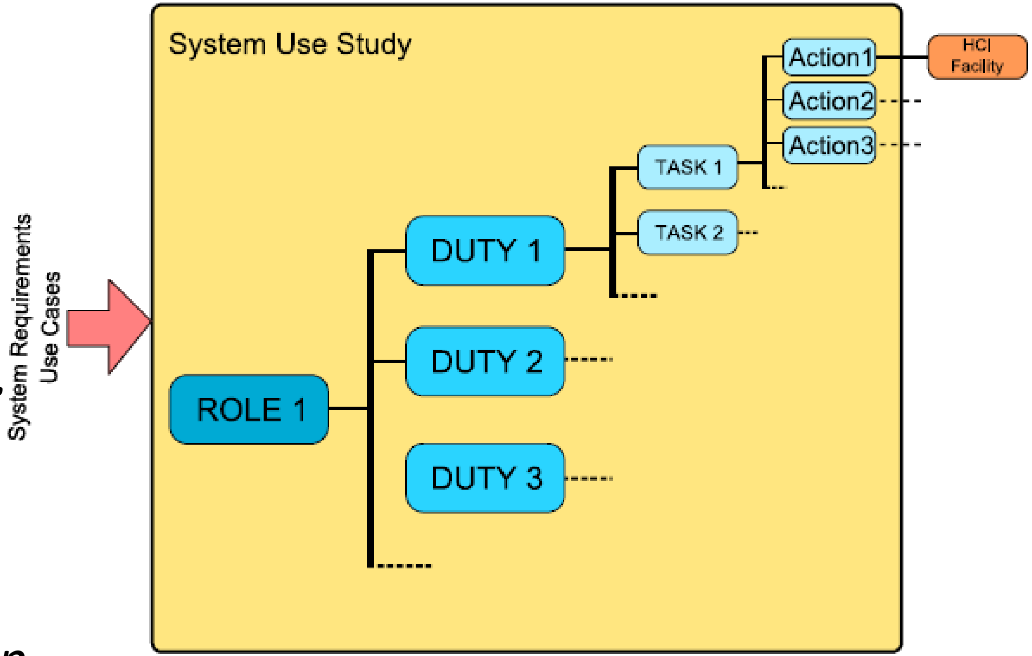
HUMAN FACTOR – Operator Requirements and Training Needs

Requirements analysis:

- *Roles – 35*
- *Duties - 80*
- *Tasks – 167*

Training Needs Analysis:

- *Planning and Supervision;*
- *Surveillance*
- *Identification and recognition*
- *Target Acquisition and Interdiction*



HUMAN FACTOR – Operator Interfaces and Training Tools

Operator Interface Design – Leave control to the User*:*

- *GUI (Graphical User Interface) solutions; control devices; ergonomy approach*
- *Unmanned Systems functionality*
- *SWARM functionality*
- *Assimilation of the new improvements – against the habbits*

Training Tools Design*:*

- *Training process – general assumption*
- *Training tools – the reality of the environment;*
- *Operator evaluation process*
- *Maritime Training Centre concept*

HUMAN FACTOR – Management

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Management aspects

- *International Company (*BE, DK, EL, ES, FR, IT, LT, PL,SE*)*
- *Building the bussines relations*
  - *Project working meetings*
  - *Revision of the documents sessions*
  - *Communication lines*
  - *Covid - 19 – adaptation to the new environment*
- *Involvement*

HUMAN FACTOR – Conclusions

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Final conclusions – Truisms ?

- *The pace of the development of technology is not going to slow down*
- *„Open source" tools availability*
- *To show possibilities in spite of formal regulations*
- *Time factor is a key for leadership / for success*
- *Interoperability is a process which demands a permanent update*
- *Innovations – YES – but according to End Users expectations – dialogue required*

Human Factors impact of UxS integration

Daniele Frisoni, Leonardo

Topics

- *UxS (Unmanned System) Integration on Naval Units for MSA (Maritime Situation Awareness)*
- *Operational Level*
  - *MOC (Maritime Operations Center) Operators*
- *Tactical Level*
  - *CMS (Combat Management System) Operators*
  - *UxS Operators*
- *Roles, Tasks and Allocation of tasks to roles*
- *Conclusions*

UxS Integration for MSA

- UxS expand and extend Naval Unit capabilities :
  - Extension of sensors coverage
    - Ensuring safe recognition, surveillance, acquisition and reconnaissance
  - New features for Mission Execution
    - Ensuring safe recognition, surveillance, acquisition and reconnaissance
  - MOC Upgrading of "Observation, Orient" steps of the OODA loop
    - Providing detailed reports at close distance
    - Allowing quasi-real-time representation of the scenario

Impact of new/upgraded capabilities

- Operator Roles
  - New specialists
  - New skills and training for existing roles
- Duties in Ship Mission
  - New assets with specific mission cycles
  - New responsibilities and procedures (e.g. safety)
  - Extending perimeter of activities
- System Tasks
  - New features, data and procedures

Operational Level - Impacts on Roles and Duties

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- Examining and evaluating all information provided by internal and external sources relevant to RMP compilation and making sure that pertinent operators are informed,
- Building up and updating a coherent EURMP.
- Resolving category and identity track conflicts.

EU-MOC RMP Director

Above Water Picture Supervisor

- Building up and updating a coherent RMP for above water part.
- Resolving category and identity track conflicts for above water part.

Under Water Picture Supervisor

- Building up and updating a coherent RMP for above under water part.
- Resolving category and identity track conflicts for above under water part.

Analyst Officer

- Analyzing collected information and results of operations to determine the identities, intentions, capabilities and activities of hostile individuals or groups and determining requirements for future operations.

System Tasks at Operational Level

- MOC tasks
  - Operational Level OODA loop
    - Evaluation of Intelligence and Tactical situation
    - Tasking of assets
  - Historical and Encyclopedic data exploitation
  - Collect and Merge detailed information into RMP
  - Manage/Monitor special events (e.g. restrictions, meteo, etc.)
  - Identifying anomalies and raising alerts
  - Generate internal and external reports

Tactical Level - Impacts on CMS Roles and Duties

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Commanding Officer

- Conduct mission analysis
- Provide planning guidance
- Identify CCIR
- Evaluate of COAs and select the best
- Approval of changes to the plan
- Comprehending changes in the AoO, AoInf, and AoI
- Being aware of the mission progress and outcome

Principal Warfare Officer

- Participation in planning process
- Preparation and recommendation of defense and force protection variants
- Be responsible for maintaining the status of own ship weapon’s systems, assets, and sensors
- Being the Key CMS mission coordinator
- Establishing and managing CMS processes to ensure that all activities support the commander’s decision-making cycle
- Supervising and managing the CMS battle rhythm with respect to target acquisition, weapon allocation and target interdiction.

Local Area Picture Director

- Direct the compilation of the tactical picture
- Supervising air, surface and below-surface picture operators

Planning Officer

- Prepare Plan
- Define COAs
- Managing received intelligence

Targeting Officer

Ensuring the best assets and weapons are used for the success of the mission

Ensuring Target Interdiction operators are aligned with the current operation

System Tasks at Tactical Level

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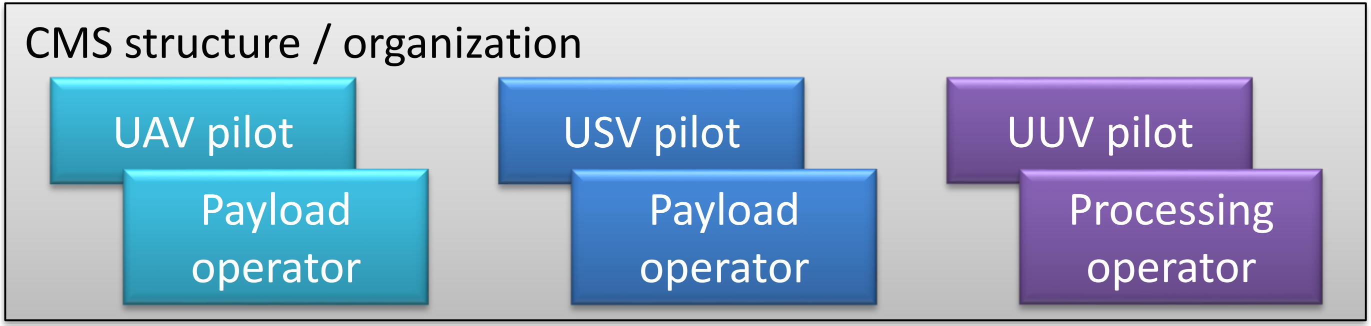
- Naval Unit new tasks or extension of existing ones
  - CMS (Combat Management Systems)
    - Tactical Observation, Orientation, Decision Making and Action
      - Surveillance, Identification and Recognition
      - Target Acquisition and Interdiction
    - Tasking, Planning of the UxS mission
    - Direction, Supervision and Monitoring
    - Data Management
    - Mission Debriefing

UxS crew

- Unmanned Vehicles Operators are part of ship crew organization
- They are enlisted as responsible to Warfare officers for UxS conduct
- Each domain UxS has its own specialized crew



System Tasks at UxS Level

- Pilot
  - Keeping UxS operational
    - Maintenances, Troubleshooting, Pre/Post-mission checks
  - Preparing UxS mission
    - Collect info, Design plan, Request authorizations, Configure vehicle
  - Executing UxS mission
    - Launch/recover, Control & navigate, Coordinate with payloads operations
- Payloads Operator
  - Keeping UxS payloads operational
  - Preparing and setting-up payloads
  - Controlling payloads
  - Optimizing resources to maximize time on task

Conclusions

- New assets/features modify Naval Units capabilities
  - Analysis of operation and tactical duties
  - Chain of command organization changes
  - Additional System Tasks
- System Tasks allocation to Operator Roles
  - Case Studies
  - Task Analysis
  - Operator Workload Assessment

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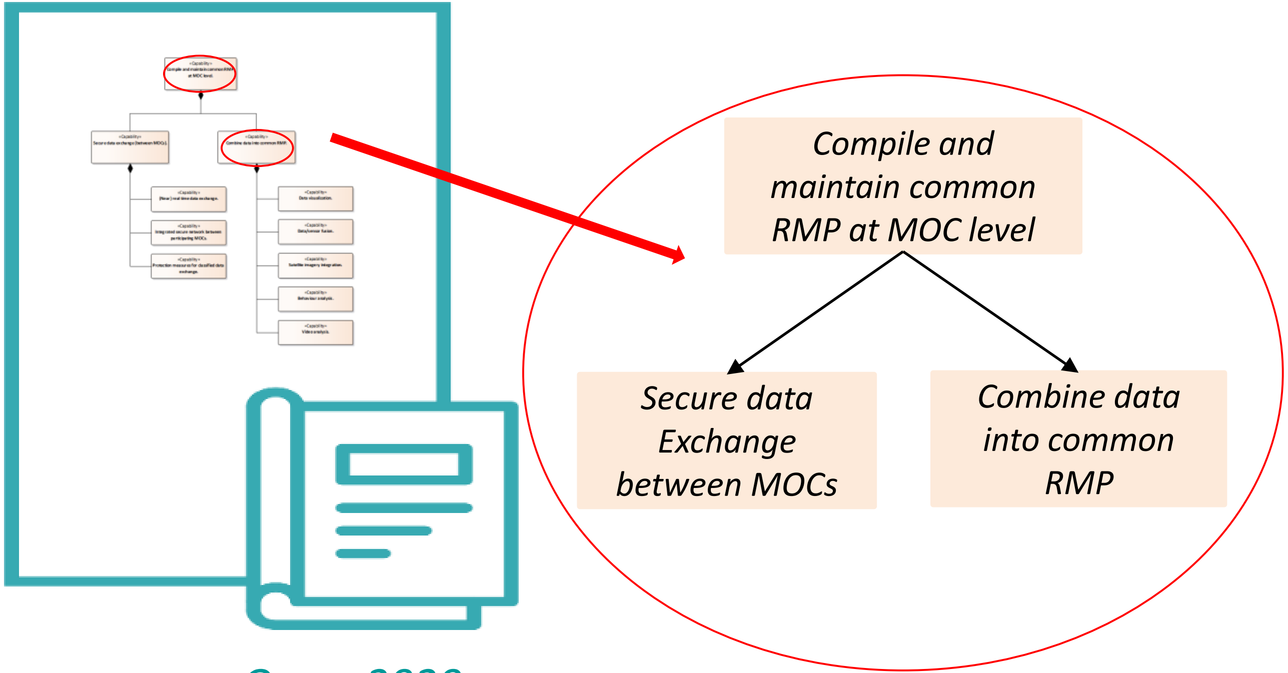
Design policy for the commanding operator interface

Fernando Barbero, Indra

Contents

- Project general framework
- MOC definition and concept
- MOC Interface design
- Conclusions and future trends

MOC definition and concept



Ocean2020 Reference Architecture

MOC definition and concept

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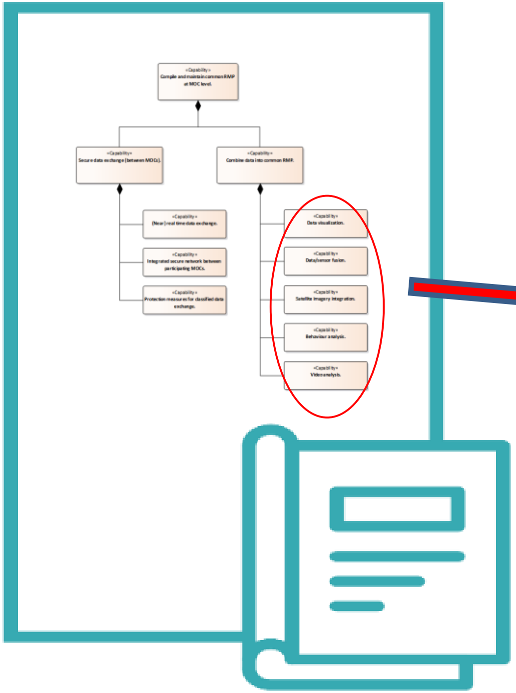

Ocean2020 Reference Architecture

- *Data Visualization*
- *Data/Sensor fusion*
- *Satellite Imagery Integration*
- *Behaviour Analysis*
- *Videoanalysis*

MOC definition and concept

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	Situation Awareness	The MOC shall provide capabilities for creating and updating an RMP from information received from sensors, CMS and additional information from internal and external databases (e.g., CISE, MARSUR)	Related to Design of Data/Images Integration and Information Fusion. The system is a able to integrate information from internal and external databases (e.g., military intelligence databases) and different civilian, military and allied sensor systems and track sources (radar, AIS, EOS, etc.) that contribute to develop a Recognized Maritime Picture (RMP) with the aim of supporting situational awareness for decision-making entities. RMP Enhancement Design In order to assist operators, the information is segmented in overlays whose visualization can be managed individually by the operators. The information received by each external System can be visualized in an independent layer. This is done to increase operator awareness about what is shared with external sources to increase coordination and reduce inter-agency communication issues.

Ocean2020 Requirements

MOC definition and concept

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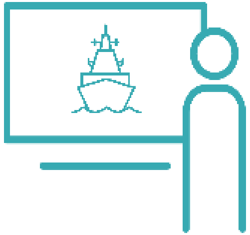
	RMP Information Accessibility	The MOC shall provide the operator having appropriate need to know with the relevant RMP information (e.g., using retrieval and visualization techniques)	Related to Design of Data/Images Integration and Information Fusion All the consolidated tracks represented on the map and all the activity processed by the system can be stored schematically and optimized for further processing or consultation. This information can be transferred to the intelligence module for its exploitation and shared with MASUR networking and TSDT System. RMP Enhancement Design SEADEF can store the historic information for all the managed tracks. Historical data for a specific track can be displayed over the GIS, so operators can evaluate the behaviour of a selected vessel. In addition, the system allows the exchange of RMP generated with MOC/participating naval units. This process is called RMP dissemination.

Ocean2020 Requirements

MOC Interface design



- Concept of design
- Components
- Logical architecture

Conclusions and future trends

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- New visualization techniques
- Automation of surveillance operation
- Operator functions related to information and communication security
- Key interface aspects and limitations

Design policy for UxV operator interface

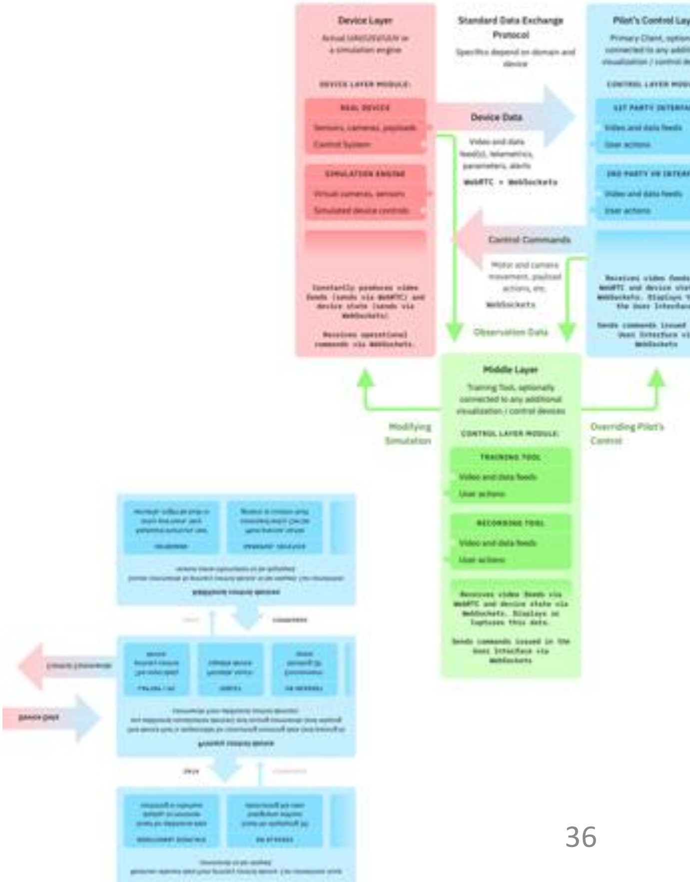
Jonas Lekevičius, BPTI

PROCESS

- Research sources:
  - Work package partners (SAAB, Leonardo, Indra)
  - End Users interviews
  - Existing industry solutions
  - Consumer technology

TECHNICAL ARCHITECTURE

- Pilot operator interface is a connected system
- Pilot might use multiple input and output devices
- Technical architecture should be suitable both for training and operation
- Open technologies is a safer bet
- Reactive interface implementation reduces complexity and errors
- Architecture for multi-party, cross-compatible development

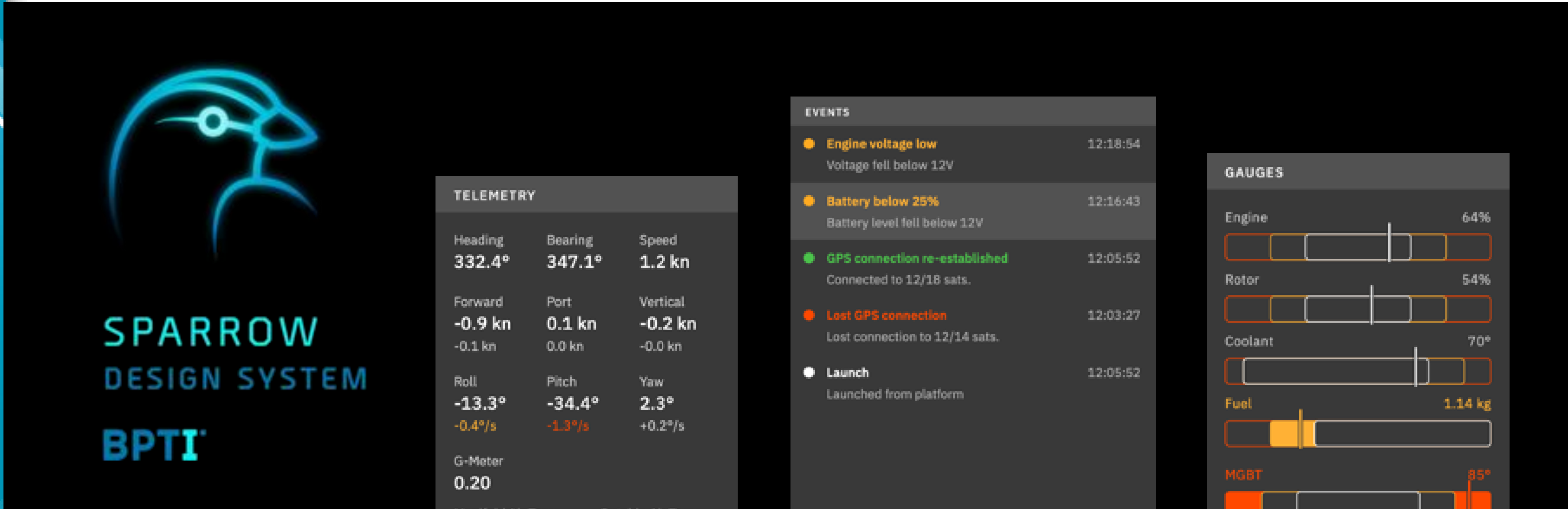


DESIGN SYSTEMS

- Design Systems is a product design innovation from the last 3 years
- From low level building blocks, such as color, typography, iconography and value display
- To high level components, such as inputs, panels, layouts, data visualizations
- Each block is built from smaller blocks
- Components can be exported and re-used
- Development effort can be re-used across systems and platforms

DEVELOPING UXS DESIGN SYSTEM

During the project, we have developed our in-house Design System for UxS, Sparrow



EXPLORING EMERGING TECHNOLOGIES

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- Innovation doesn’t have to mean using flashy, cutting-edge technologies: there’s plenty to adopt from already mature technologies
- The most well defined interfaces are standard, desktop-based, and hardware controllers (joysticks, control panels)
- Just beyond that: touch inputs and voice commands
- Cutting edge: Virtual Reality, Mixed Reality

UXV OPERATOR INTERFACE ADAPTATIONS

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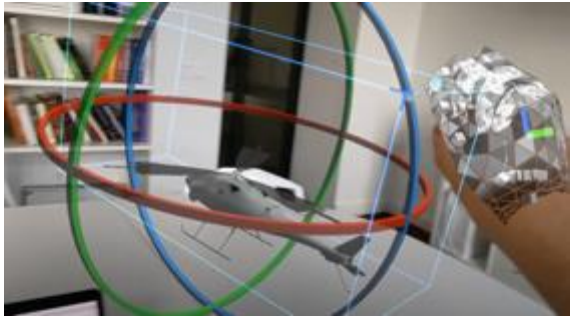
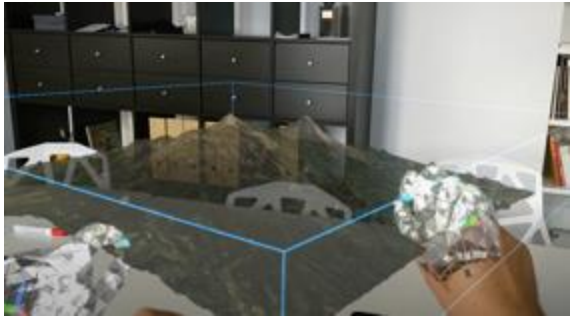
- Consider multi-modality and augmenting existing interfaces: Mixed Reality and Voice can be additive interface layers
- Rethink data visualization: holographic headsets allow for actual 3D display in a 3D space, no need to limit yourself to floating screens
- Allow end-user customization: practical experiments will allow use-case discovery





Advanced Technologies – AR, VR

Anna Bartnik, Marta Zapart, CTM

IMMERSIVE TECHNOLOGIES

Immersive - the process of "immersing" or "absorbing" a person by electronic reality.
There are 3 types of immersion technologies:

- Virtual reality

It allows to take the user to a completely fictional environment.

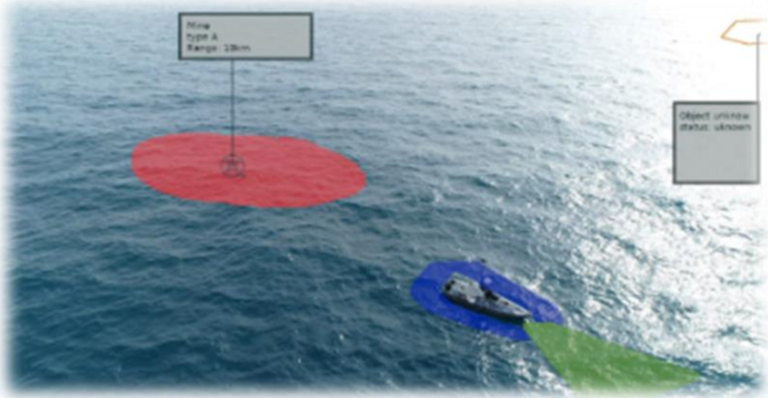
- Augumented reality

It allows to expand the image of the real world by overlaying it with virtually generated objects.

- Mixed reality

It is a combination of AR and VR technologies.

THE USE OF AR IN NAVIGATION



THE USE OF AR IN RECOGNITION

THE USE OF AR IN TRAINING

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THE USE OF AR IN MAINTANENCE

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VR TECHNOLOGY IN TRAINING

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- simulators

VR TECHNOLOGY IN UX DESIGN

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- Operator interface design, tests and user experience recommendations.
- Construction and organization of the operator's position at the space of ship.

VR TECHNOLOGY IN ADVANCED INTEGRATED SYSTEM OF INFORMATION

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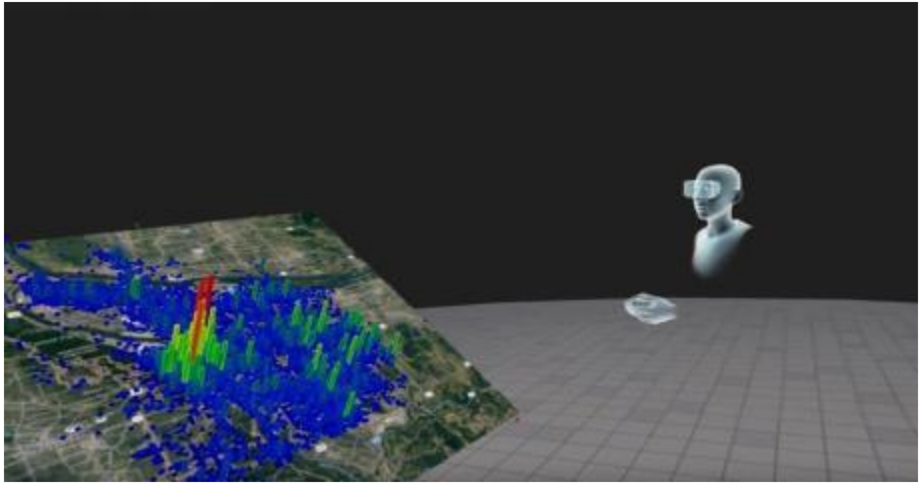
- Information analysis and building 3D models.
- Getting to know the environment and the mission scenario.



EXAMPLES

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LEONARDO

S&T organization CMRE

indra

Fraunhofer IOSB

SAAB

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SAFRAN

IDE INTRACOM DEFENSE

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gmv

MBDA MISSILE SYSTEMS

IDS INGEGNERIA DEI SISTEMI

TERMA ALLIES IN INNOVATION

ECA GROUP make sure

FINCANTIERI

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VTT

CYBERNETICA

UMS SKELDAR

SEADRONE

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HELLENIC REPUBLIC National and Kapodistrian University of Athens EST. 1837

PROLEXIA

SCHÖNHOFER SALES AND ENGINEERING GMBH

ANTYCIP simulation

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