THALES
Building a future we can all trust

eXtended Reality for seamless human-robot interactions

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Journée thématique sur les outils XR pour l'interaction Humain-Machine
June, 5th 2025 - Poitiers
www.thalesgroup.com

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Introduction

CortAIx – 3 pillars to deliver end-to-end AI superiority

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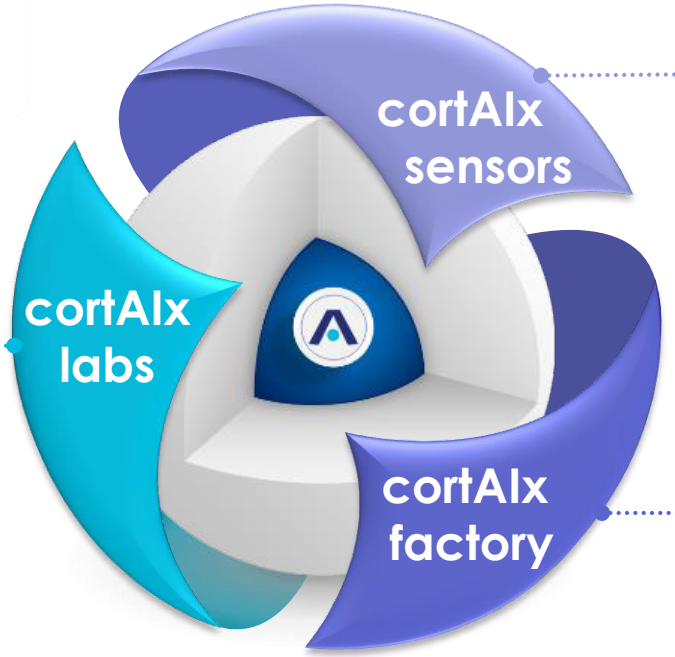
Artificial Intelligence by THALES



Sensors

Embedding AI at the heart of sensor processing, reaching **multiplying effects** in field performance & efficiency

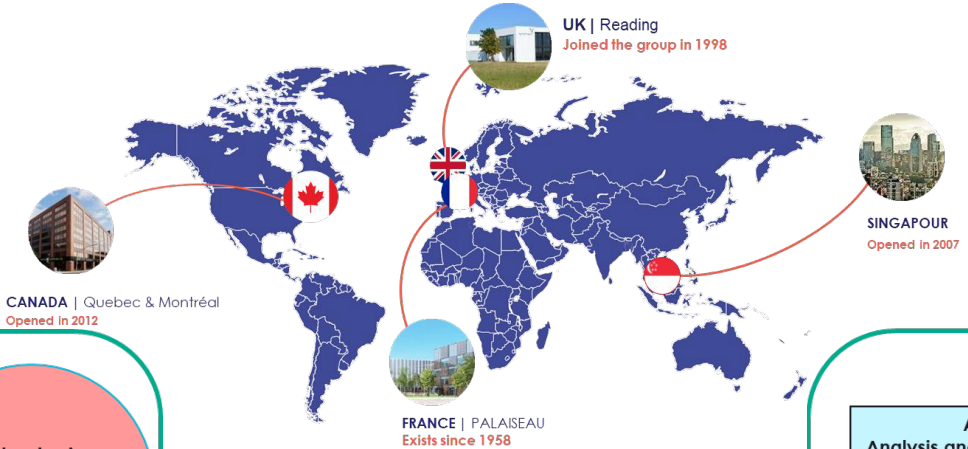
Labs

Advances **AI research**. Develops **superior & trustworthy algorithms and enabling technologies** for critical environments

Factory

Integrates AI-powered sensors & algorithms into **systems of systems** to create differentiating capabilities and accelerate **operational deployment** on the field

TRT Palaiseau, home of two Research entities



HARDWARE

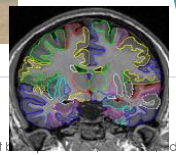
- Physics Research Group (GRP)
  - laboratoire Albert Fert
  - cnrs
- Technologies and Materials Research Group (GRTM)
- GIE III-V Lab
  - III-V lab
  - cea leti
  - NOKIA

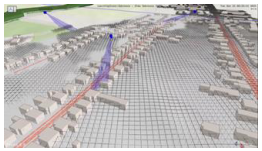
cortAIx Labs

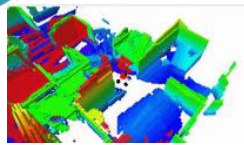
- ARX — Analysis and Reasoning in Complex Systems Lab
- DS6 — Data Science Lab
- CES — Critical Embedded Systems Lab
- HPC — High Performance Computing Lab
- CYB — Cybersecurity Lab
- S2E — System & Software Engineering Lab
- D&O — Decision & Optimisation Lab
- VAR — Vision, Autonomy and Robotics Lab

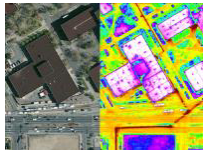
Formal Lab (cea list) · GenAI (cea list) · SINCLAIR (TotalEnergies, EDF)

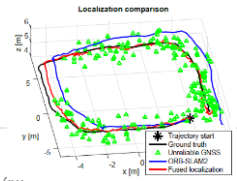
VAR activities











Quantum Secured Networks

Quantum Communications

Quantum Information Networks

Person & vehicle detection & tracking

Face recognition

Human/robot interaction

Collaborative robotics

Video captioning

AI for perception

Embedded processing

Autonomous Systems

Multi-sensor fusion

Event detection

Deep Reinforcement Learning

3D reconstruction

Object classification

Image segmentation

Large Scale Multi-Agent Simulation

Geolocation

Training & Simulation

Large Terrain Drone Simulation

What-If Decision Support

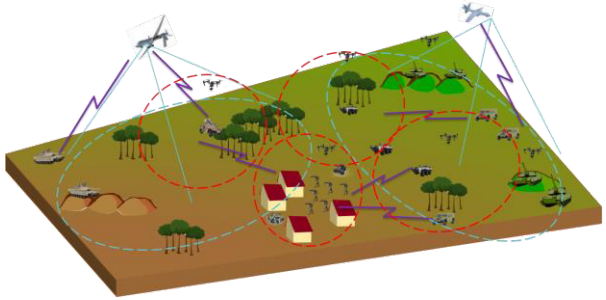
Human-Autonomy Teaming

Modelling dynamic task allocation and autonomy adjustment

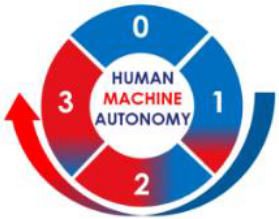
AI and XR for human / autonomous systems interactions

Human-machine interactions in Collaborative Combat

Collaborative Combat involves geographically distributed manned vehicles, semi-autonomous systems and autonomous robotic platforms



Need to take into account the Human-Autonomy Teaming aspects



Need for natural, immersive and intuitive interfaces

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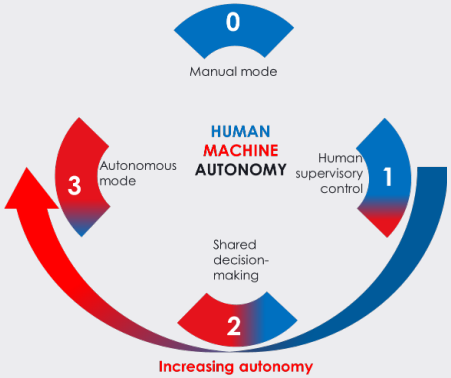
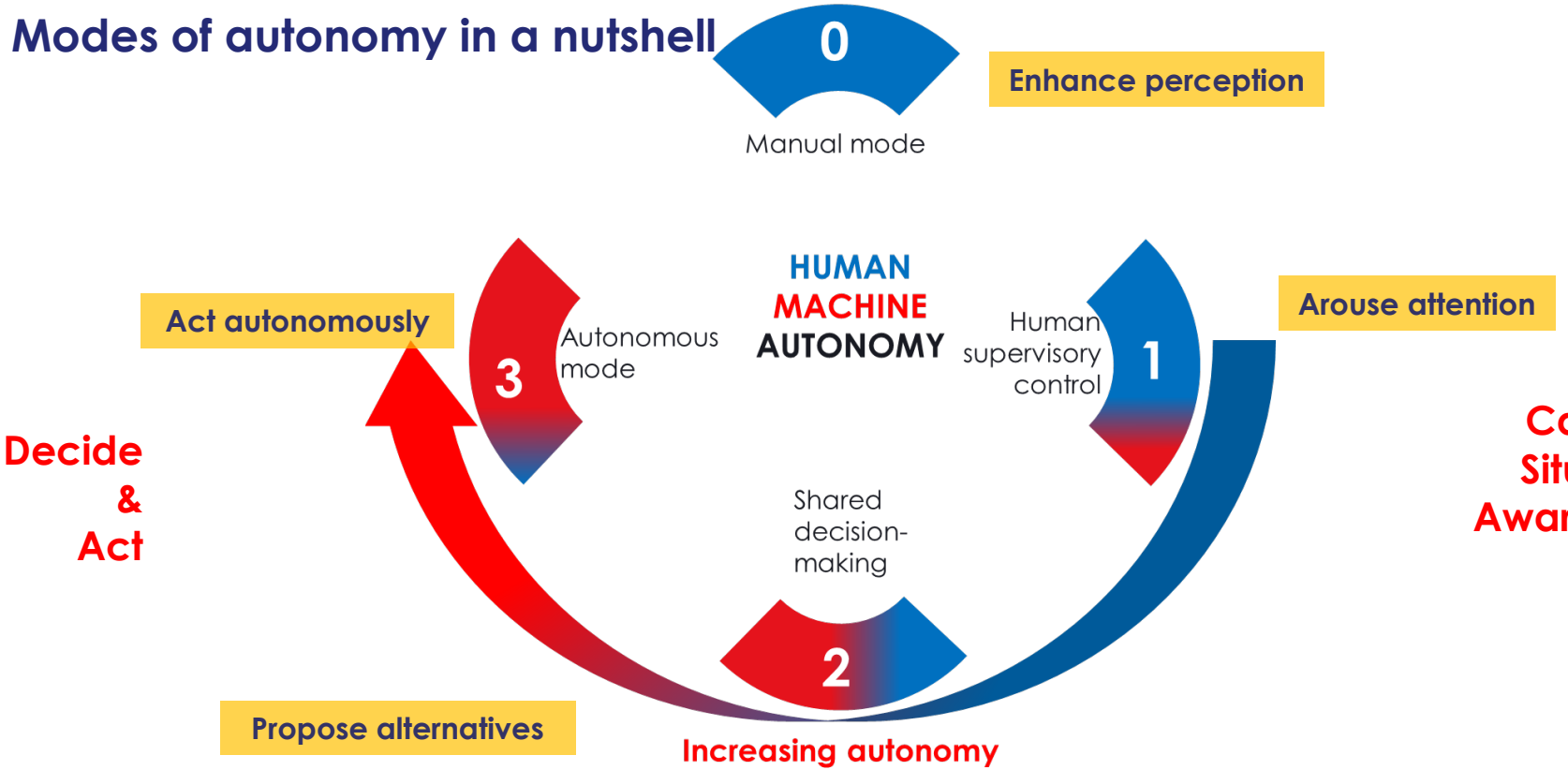
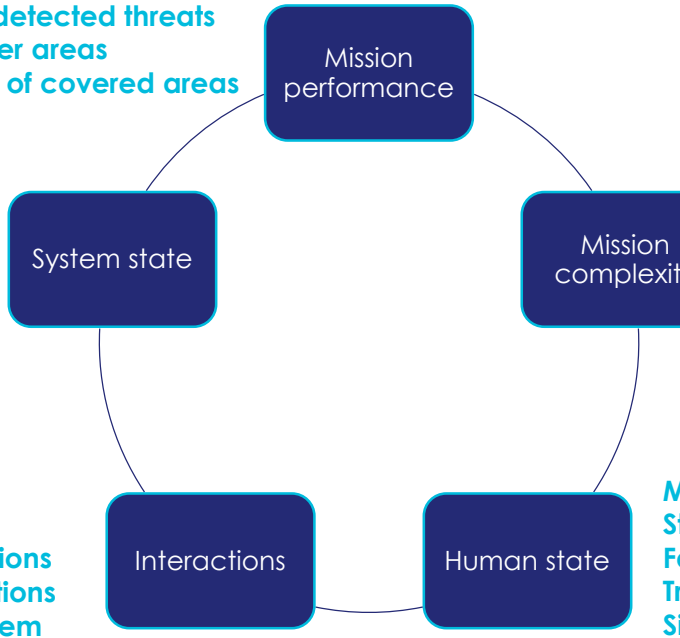
Modes of autonomy and Human-robot interactions



Modes of autonomy in a nutshell



Foreseen KPIs to assess performance of Human-Swarm Teams



Time for mission completion
Percentage of mission completion
Number of detected threats
Time to cover areas
Percentage of covered areas

Nature of terrain
Number of obstacles
Weather conditions
Communication constraints
Task structure (parallel tasks and task interruptions)

Mental workload
Stress level
Fatigue and vigilance
Trust
Situation Awareness
Engagement index

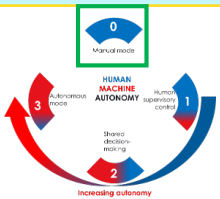
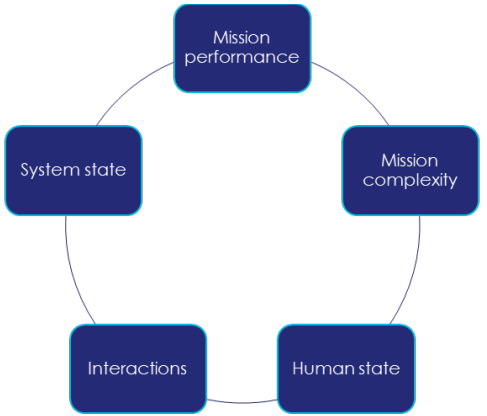
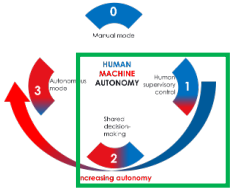
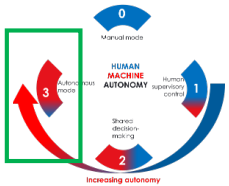
Number of interactions
Duration of interactions
Time to solve problem
Ratio autonomous mode to manual mode
Ratio operator vs. number of controlled drones
Neglect tolerance

Number of drones
Resources depletion
Total damage to the swarm
Swarm level of automation

Assess expected workload during mission preparation

Assess real-time workload during mission execution

Human in/on/out of the loop description and assessment

Term	Human role	Mode of autonomy	Example	Assessment
Human-in-the-Loop (HITL)	Human takes decisions and acts in real-time		*XR* Pilot manually chooses the drone trajectory	HOOTL : Loss of control, explainability, take over  HOTL : Loss of vigilance, overtrust HITL : High cognitive workload
Human-on-the-Loop (HOTL)	Human supervises and can intervene if needed		*XR* Drone executes navigation task autonomously but human can take control back	
Human-out-of-the-Loop (HOOTL)	Human does not intervene at all during the action		*VR* Drone executes a mission without active supervision	

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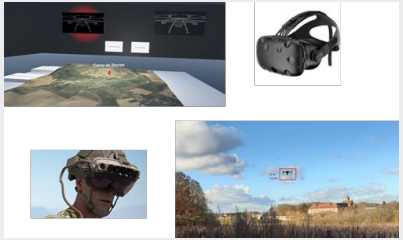
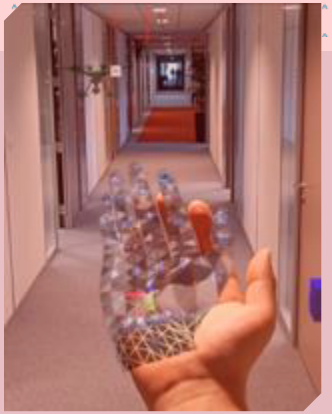
XR for Human-Robot interactions



Human-Robot Interactions

VR/AR headset supported



Remote controllers

(Highest TRL)

+ Low latency

- Cumbersome

- High cognitive workload

Gestures

(Medium TRL)

+ Intuitive

+ High-level orders

- Low accuracy for direct piloting

Speech

(Medium TRL)

+ Intuitive

+ Hands free

- Environment dependent

Gaze

(Medium TRL)

+ Intuitive

- High workload

Brain-Computer Interface

(Low TRL)

+ Hands free

- Low accuracy

- High cognitive workload

AR, VR, MR, XR…

From Milgram and Kishino, 1994

Define the best suited modality

For the type of task to be performed : supervision or direct control

For the expected level of automation

VR for drone supervision and payload control

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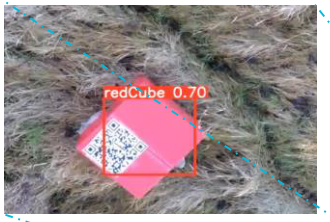
General architecture

Embedded AI capabilities

Control embedded camera via headset movement

1st person view of embedded camera

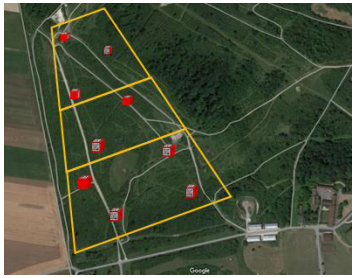


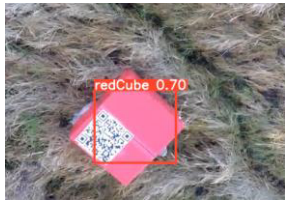
Supervision room

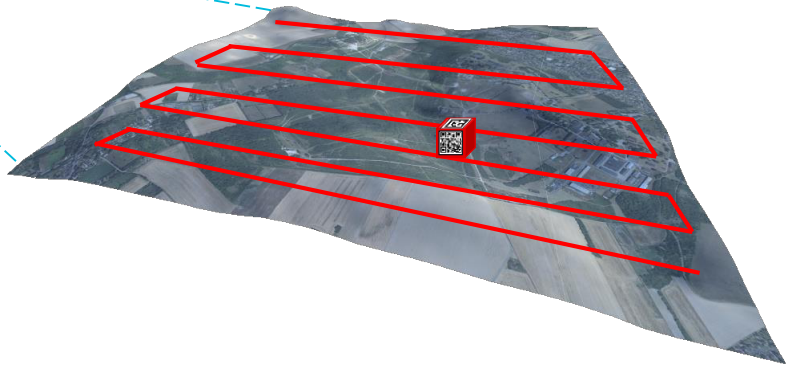
RTSP video and metadata streaming

Interact with 3D supervision room (headset and controllers)

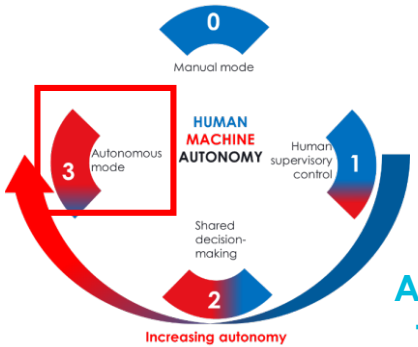
Technical demonstrator



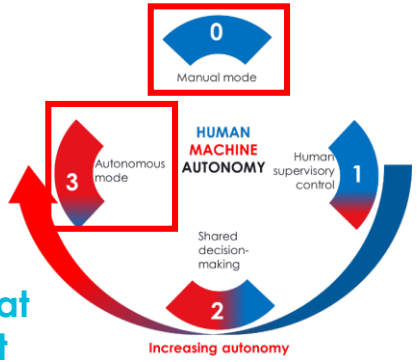




Navigation



DRI



Autonomy shall not be defined at the system level but at the task level and adjusted depending on the context

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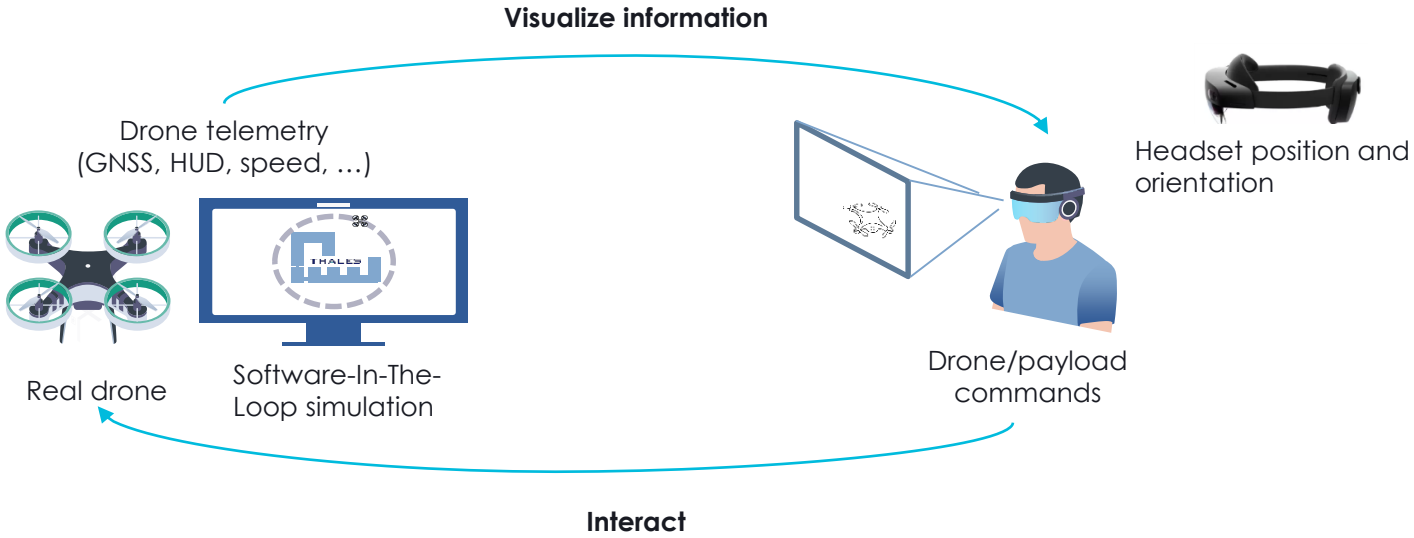
XR for drone control

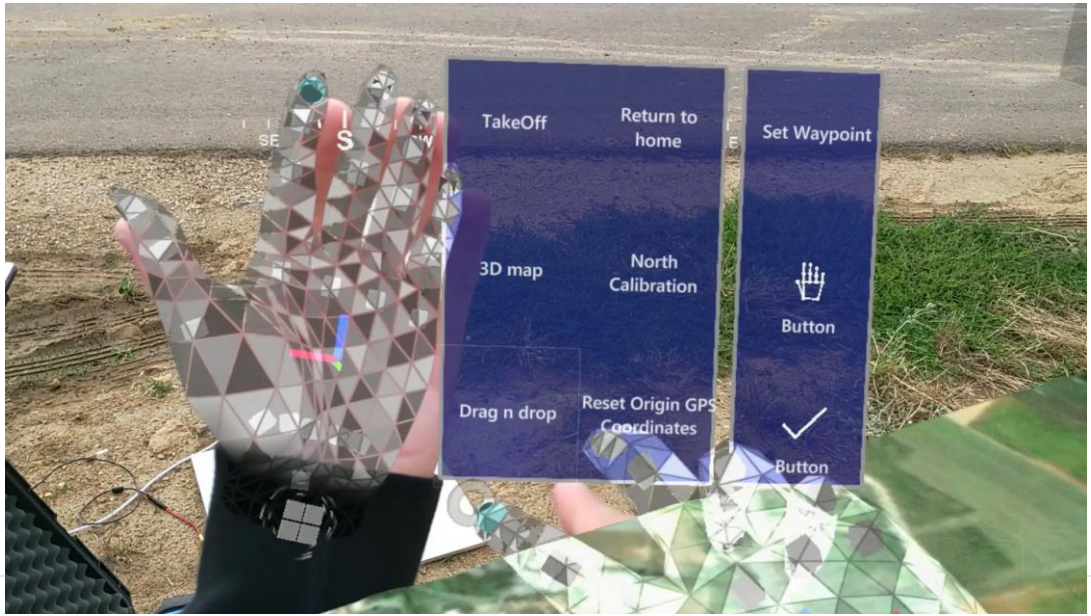
AR Technical demonstrator



Functionalities and User Interface design to ensure Situation Awareness on the field

AR heads-up display for drone direct control

- Highlight drone position for enhanced perception and easier interaction
- Drag and drop drone visualization to new position
- Command sent to the drone in real-time



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AR heads-up display for drone control using 3D map

- Interactive 3D map displayed to the user
- Position on the map updated in real-time
- Command sent to the drone in real-time

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Conclusions and perspectives

Conclusions and perspectives

- Immersive interfaces shall contribute to building and maintaining situation awareness without adding cognitive workload

- Seamlessly share information between tactical and operational levels and extend interactions to swarm level

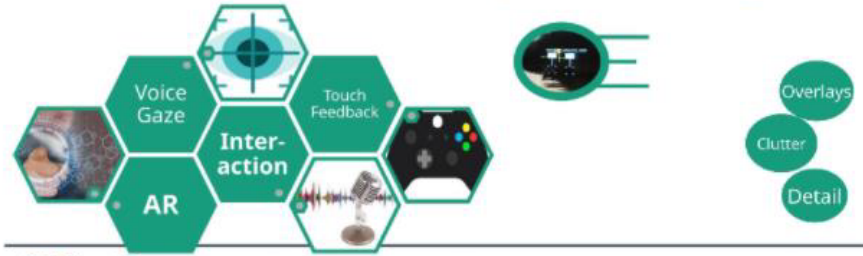
- Subject to users' acceptance and operational constraints

- Increasing topic of interest in national and European calls: Horizon Europe (Cluster 3 and Cluster 4), FED, ANR ASTRID, AMI…

NORTH ATLANTIC TREATY ORGANIZATION
SCIENCE & TECHNOLOGY ORGANIZATION

AVT-MSG-HFM 401 on

AR in land operations: balancing risks and chances in technical and human systems challenges



Team leader(s):	**Marcel Baltzer (DEU)** **Luke Gallantree (GBR)**
Panel Mentor	**HFM: Frank Flemisch (DEU)**
Members:	**DEU, GBR,** FRA, EST, NLD, USA
Interested nations:	FIN, NOR, SWE
Duration:	**Jan 2025 – Dec 2027**
Coordination:	***HFM, MSG, LCG/LE***
Related activities:	***AVT-HFM 216, AVT-IST 398, HFM 330***

Objectives:

Define the scientific key aspects that need to be addressed in order to make AR feasible in land platform operations. A key objective are solutions how to balance qualitative and quantitative, and subjective with objective data.

Topics covered:

- *Use space: dimensions of AR uses*
- *Design space: dimensions of AR designs*
- *Human Machine System perspective*
- *Human centred perspective*
- *System of systems*

Impact and Exploitation: DOTMLPFI

- *Best practices for data exploitation with AR*
- *Standardisation of AR on multiple layers of interaction, e.g. patterns, for the military domain*
- *A common vision and roadmap of feasibility and usability of AR*
- *Improved accessibility of the results at specific periods of the RTG for industry to develop useful AR solutions*
- *Improved mission rehearsal capability*
- *Strengthening and integration of the cross panel activities of AVT, MSG and HFM in the areas of AR and Human Systems Integration*

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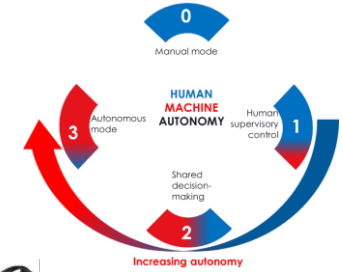

Thank you !

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