2021

Annual report

cnit
consorzio nazionale
interuniversitario
per le telecomunicazioni

National Lab
RaSS
Radar and Surveillance Systems

Director's Introduction

Welcome to the 2024 Annual Report of the Radar and Surveillance Systems (RaSS) Laboratory.
This edition is intended to provide a comprehensive overview of the research activities carried out in our Lab over the past year, along with the key results and milestones achieved during the 2024 financial year.
As in previous years, 2024 has been a highly productive and rewarding period for RaSS, marked by several significant accomplishments:

- Strengthening of our team, with the addition of 2 new permanent researchers and 3 fixed-term positions.
- 35 active research projects.
- 47 scientific publications.
- Participation in 20 conferences, workshops, and specialist meetings by 17 of our team members.
- Leadership in three NATO activities and involvement in one additional NATO initiative.
- Approval of 8 new project proposals, with their activities set to begin in early 2025.

To ensure clarity and accessibility, this report has been kept concise, offering a snapshot of our main initiatives and achievements. For further details or inquiries, feel free to contact us at: rass@cnit.it.
Two years ago, I started my adventure as Director of the RaSS Laboratory. It has been, so far, an incredible journey made truly special by the dedication and passion of our researchers, colleagues, and administrative staff. Your enthusiasm continues to inspire me every day. Let's keep up the great work!

Agostino Monorchio
Director of RaSS

cnit consorzio nazionale interuniversitario per le telecomunicazioni

National Lab RaSS Radar and Surveillance Systems

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THE RADAR AND SURVEILLANCE SYSTEMS LABORATORY AT A GLANCE

The Radar and Surveillance Systems (RaSS) Laboratory is one of the National Laboratories of the National Interuniversity Consortium for Telecommunications (CNIT), a non-profit consortium comprising 50 research units—42 from Italian universities and 8 from CNR institutes—and 8 national laboratories. More information is available at https://www.cnit.it/en/.

Established in 2010, the RaSS Lab was created to bring together a critical mass of expertise in radar systems and applied electromagnetics, addressing the growing challenges of research and innovation in these fields. Today, RaSS is home to a team of 32 people, including researchers, technical personnel, and administrative staff.

Over the years, RaSS has led or contributed to numerous national and international research projects funded by a wide range of institutions: the Italian Ministry of Defence (MoD), European Defence Agency (EDA), Ministry of Education (MIUR), Ministry of Economic Development (MISE), European Commission (EC), European Space Agency (ESA), EOARD (European Office of Aerospace Research and Development), NATO (via SPS and NCIA), the Italian Space Agency (ASI), and the Tuscany Region.

RaSS is committed to maintaining and enhancing the quality and excellence of its research. It continuously works to strengthen its internal structure and to invest in foundational research across emerging domains. Positioned at the intersection of academia and industry, the laboratory plays a key role in bridging the gap between research and practical applications. Several projects developed at RaSS have resulted in integrated demonstrators with Technology Readiness Levels (TRLs) between 5 and 6.

The lab is also highly active in dissemination and knowledge transfer, contributing to scientific literature through journals and books, and engaging in international conferences, workshops, short courses, seminars, and industry-focused training sessions.

RaSS proudly collaborates with over 50 partners worldwide, including universities, research institutions (both governmental and non-governmental), and industrial stakeholders. It maintains a strong presence within NATO and EDA frameworks, with staff members playing leading roles in Panels and CapTechs. The Lab also actively participates in joint research and experimentation at the "Ugo Tiberio" JCC Lab, a collaborative facility between the Italian Navy's CSSN and CNIT.

RaSS has also fostered successful technology transfer through the creation of two spin-off companies: ECHOES, specializing in radar systems design and development, and FREE SPACE, focused on advanced antenna systems and electromagnetic technologies. Both companies extend the lab's impact beyond research, enhancing its role in innovation and industry collaboration.

FINANCIAL STATS

The RaSS Laboratory budget is supported by several sources of funding through various research projects. The following figures outline the lab's projects and financial trends from FY 2020 through FY 2024.

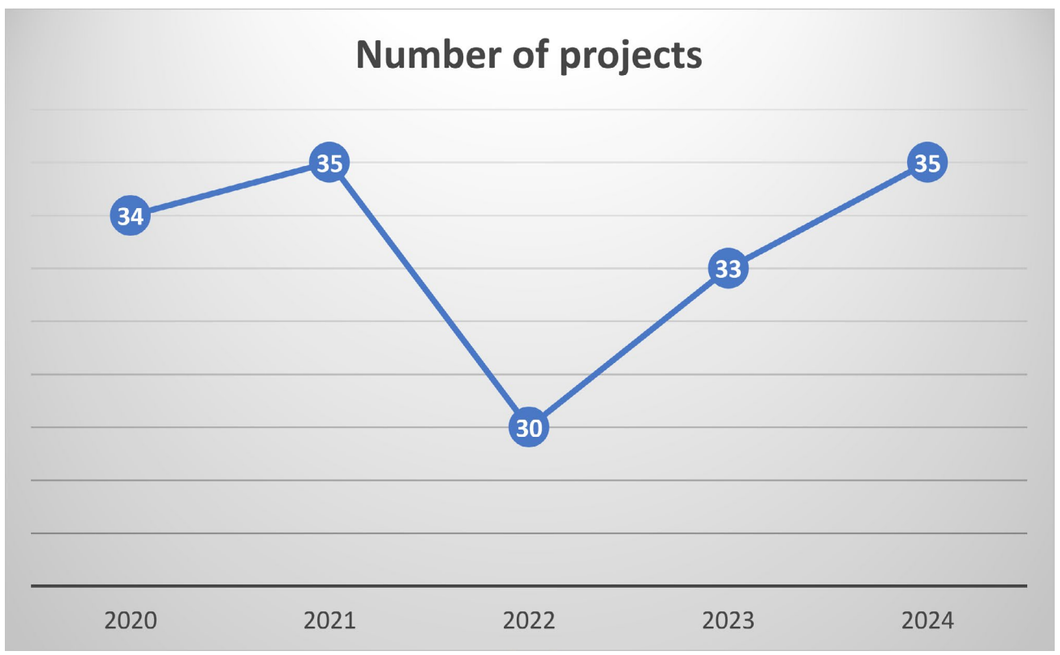


Figure 1 - RaSS Lab number of projects in progress FY 2020 through FY 2024

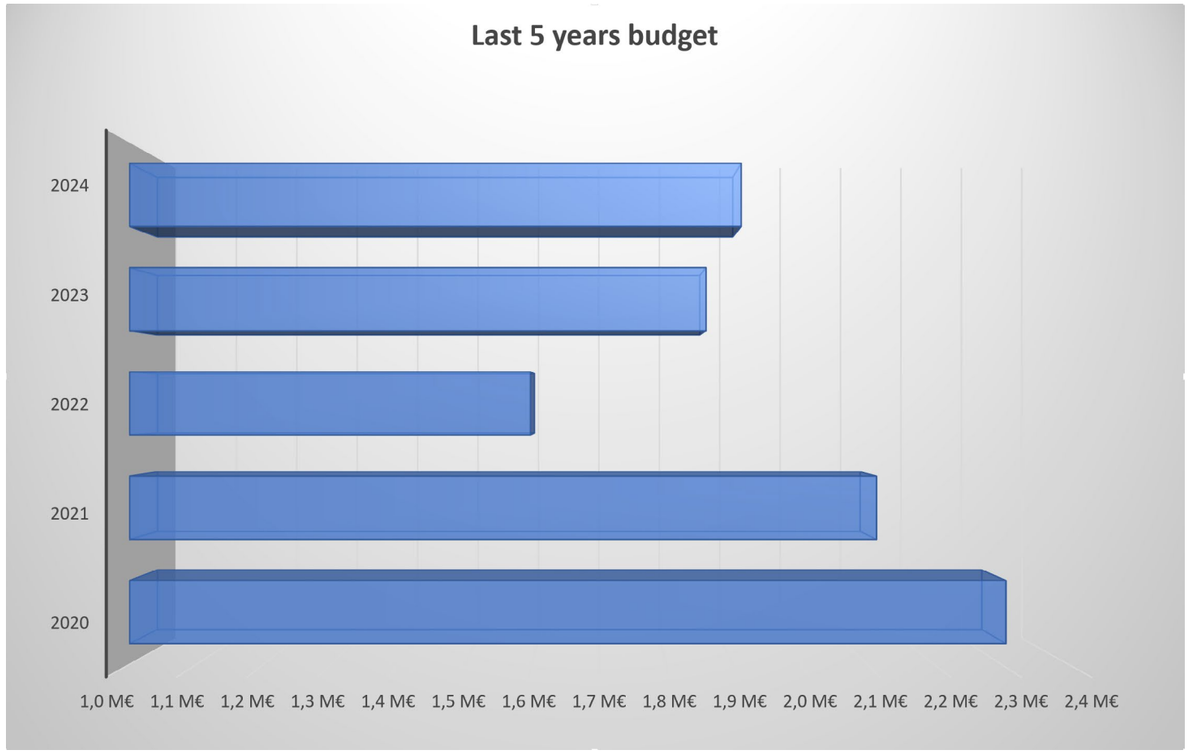


Figure 2 - RaSS Lab financial trend from FY 2020 through FY 2024

ORGANISATION CHART

Figure 3 shows the organisational chart of the RaSS Lab as at the end of 2024. This diagram illustrates the structure of the organisation and the relationships of its governing bodies and positions. The RaSS Lab is organized in five research areas, namely radar systems, radar signal/image processing, remote sensing, antennas, electromagnetic modelling & metamaterials. RaSS also has an explorative research area, where promising basic research is internally funded, and instrumental laboratories. On the administration side, RaSS is composed of a secretariat office, a quality control office and a safety and prevention office. RaSS activities are disseminated by the media & communication board. RaSS governance is directed by the Steering Committee, which is chaired directly by the Director.

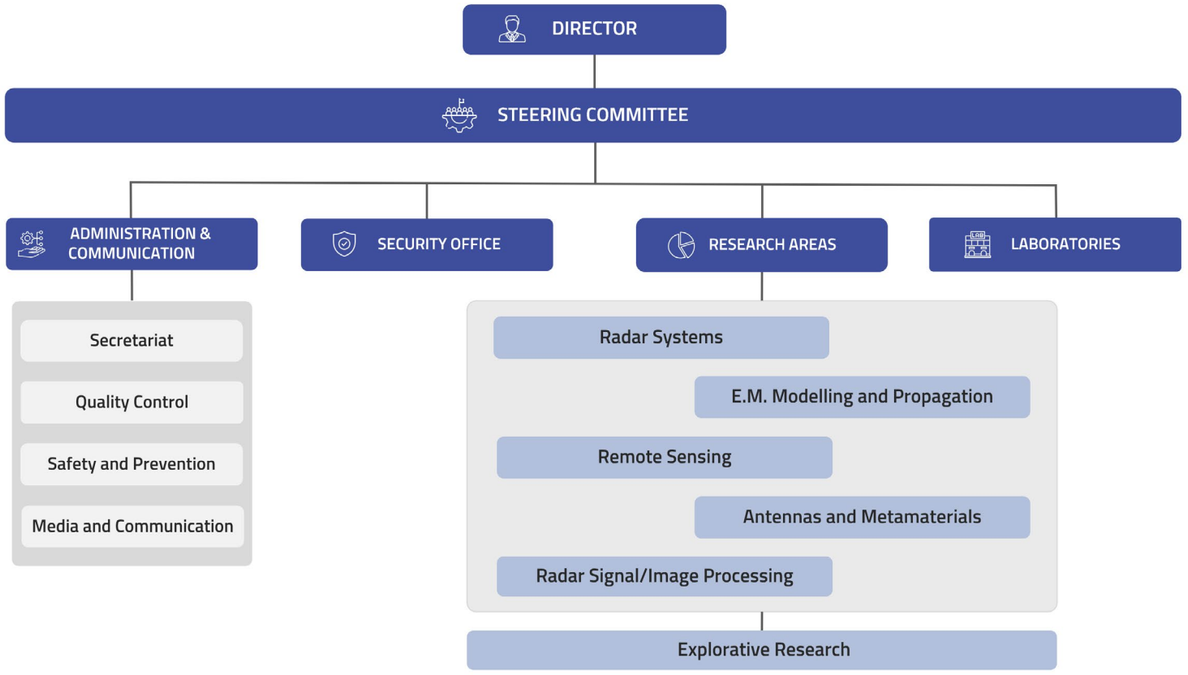


Figure 3 - Organisational Chart.

DIRECTOR

Prof. Agostino Monorchio graduated (laurea degree) at the University of Pisa in Electronic Engineering in 1991 and he earned his PhD on 'Remote Sensing and Environmental Monitoring' in 1994. In 1995 he worked as microwave radioastronomer engineer at Arcetri Astrophysical Observatory, Florence (IT). In 1996 he started his academic career at the same University of Pisa as Assistant Professor where is now Full Professor of Electromagnetic Fields at the Department of Information Engineer. He has been Adjunct Professor at Pennsylvania State University (USA) and he is presently Adjunct Professor at Italian Naval Academy in Leghorn. He spent several research periods at the Electromagnetic Communication Laboratory at Penn State University, both as a recipient of a scholarship (Fellowship Award) of the Summa Foundation, New Mexico (USA), and in the framework of CNR-NATO Senior Fellowship programme. He has been visiting scientist at the Department of Electromagnetics, University of Granada, Spain and at Beijing Institute of Space Long March Vehicle, China. He is a member of the Scientific Advisory Board of Directed Energy Research Center of TII (Abu Dhabi, UAE). Since 2023, he is Head of Radar and Surveillance Systems (RaSS) National Laboratory of CNIT (Consorzio Nazionale Interuniversitario per le Telecomunicazioni). In the same year, he has been appointed as Italian member of Sensors & Electronics technology (SET) Panel of NATO-STO. Prof. Monorchio is active in a number of areas including computational electromagnetics, microwave metamaterials, radio propagation for wireless systems, the design and miniaturization of antennas, electromagnetic compatibility and biomedical microwaves applications. He has carried out a considerable research activity and technical consultancy to national, EU and U.S. industries, coordinating, as principal scientific investigator, a large number of national and European research projects. His research results have been published in more than 180 journal papers and book chapters, and more than 300 communications at international and national conferences, he is co-author of 6 patents. One of his papers on radomes with both transparent and absorptive properties (doi: 10.1109/TAP.2012.2194640) has been selected as one of the 20 most influential papers in the history of IEEE Transactions on Antennas and Propagation. In 2012 he has been elevated to Fellow grade by the IEEE for his contributions to computational electromagnetics and for application of frequency selective surfaces in metamaterials, and is cited as one of Top Italian Scientists in https://topitalianscientists.org.

Active Projects

PROJECT AI4CUAV

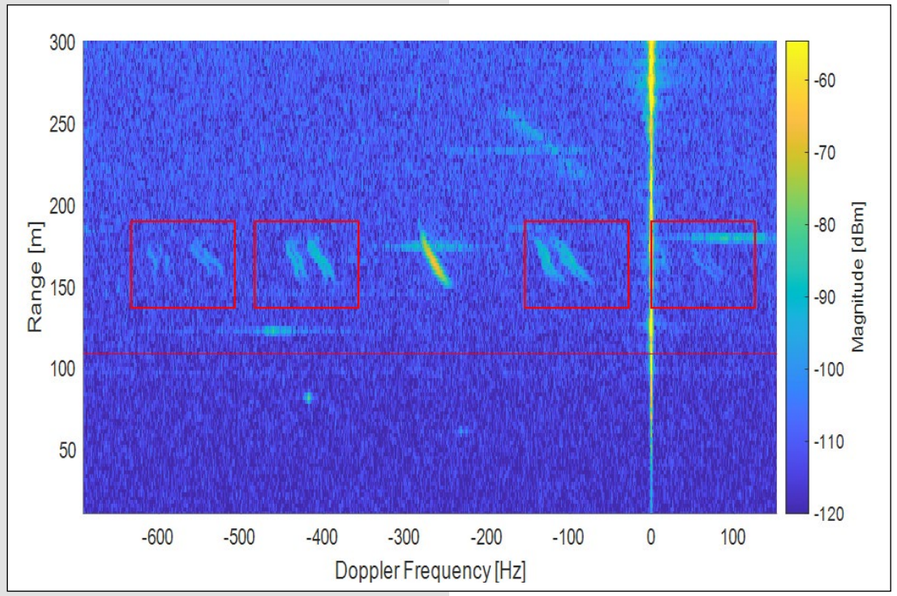
Innovative AI-framework to enable the detection, classification and tracking of killer- drone

The current AI-based algorithms on detection and classification algorithms based on radar signatures (i.e. signals and images) have shown a non-reliable solution in detecting and classifying small UAVs. A combined system with the EO/IR detection and classification based on AI-techniques could improve the required performances. Ai4CUAV intends to improve the Threat Evaluation Subsystem of a counter UAV (C-UAV) through AI-based algorithms. Supposing the anti-drones composed of multiple heterogeneous sensors, such as radars and EO/IR sensors, these algorithms "work" on radar signals and EO/IR images to enable the detection and classification of the killer-drones, as well as on drone trajectories to help to recognize a drone from another object. This project will build a shared database of RF and EO/IR
signatures of different drones which can be used as training data and test set, which allows to compare different detection and classification techniques. Ai4CUAV will investigate all the key SOTA of AI techniques from multiple sensor sources, including but not limited to, machine learning and deep learning. These techniques will be evaluated against the different use cases and scenarios, in order to assess the most adapted/promising ones. For the most promising techniques, algorithm prototyping and adaptation will be performed to assess preliminary performances through simulations. This project is a follow-on of the NATO SPS project n. G5633 "ANTI-DRONES – Innovative concept to detect, recognize and track killer-drones", involving the core partners CNIT-RASS (NPD) and MTU (Co-Director), that will be concluded in September 2022 with good results, focused on the development of a new concept of anti-drone system, based on mini-radar technology and signal processing, able to detect, recognize and track the killer-drones – mini/micro UAS – in order to facilitate the neutralization of them minimizing the risk for people and assets. This AI-framework will be integrated in the ANTI-DRONES prototype, tested and evaluated by the end-user experts. Ai4CUAV project is a research project focused on a breakthrough innovation using AI. As such, it is expected to advance the accuracy of detection algorithms, and set forward AI-based solution of high complexity problems. From a prospect vision, Ai4CUAV would bring into market a novel and innovative AI application enabling intelligent ISR in complex situations.

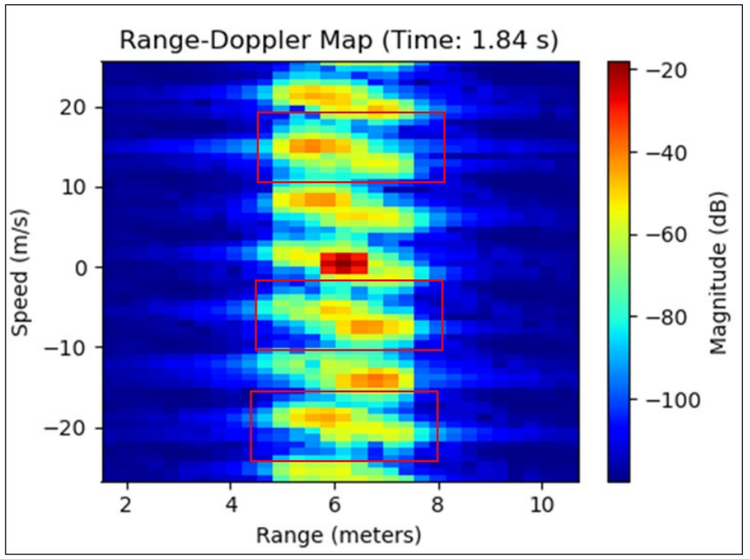
Keywords: Drone detection, AI (Artificial Intelligence), Target classification, Target Motion Analysis (TMA)

AI4CUAV

Technical Sheet
Funding institution:
NATO-SPS
Project partners
IUS, MTU, GPI, UniLink, KhNUIA
Project duration
March 2024 – September 2026
Involved countries
Ukraine, Bosnia and Herzegovina, North Macedonia, Germany, Moldova, Italy

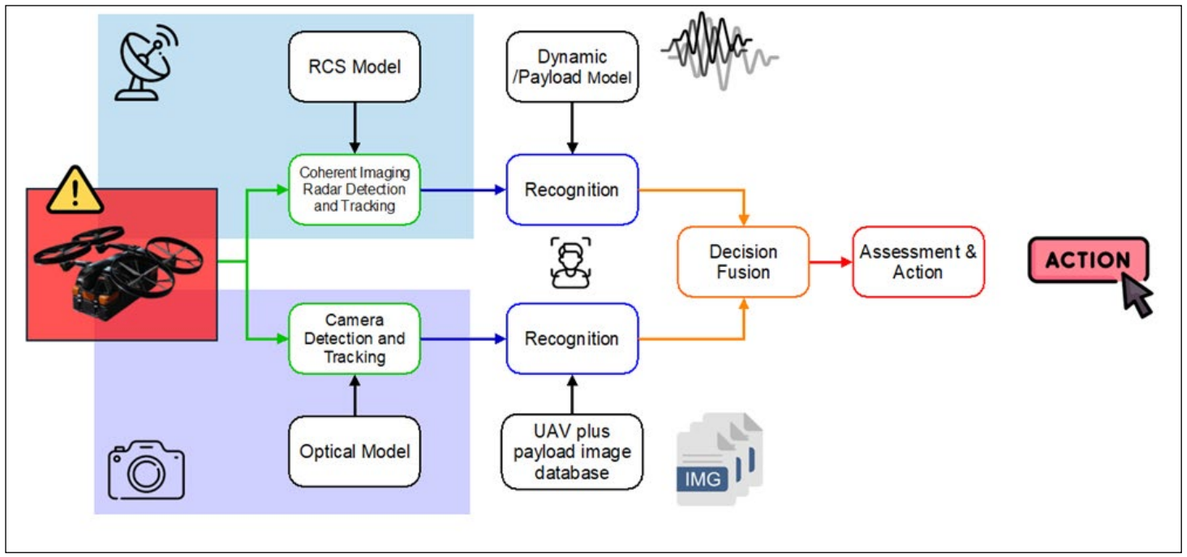


(a) Real Range-Doppler map of a drone



(b) Simulated Range-Doppler signature of a quadcopter using the same RF parameters of the real radar

(c) Hefesto drone shown in the real Range-Doppler map



(d) Final classifier architecture involving the fusion of multi-sensor data. AI-based algorithms will be used to obtain the detection and fuse the data.

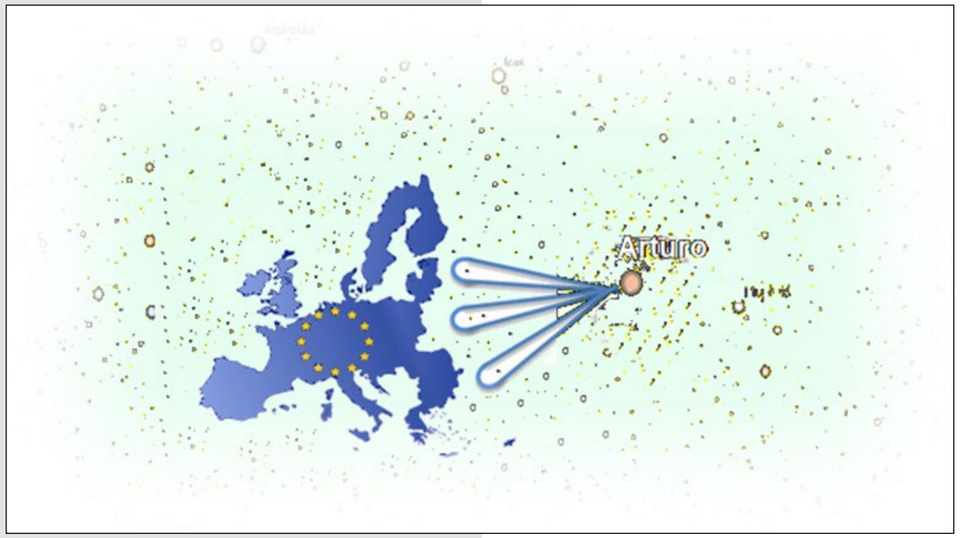
PROJECT ARTURO

Advanced Radar Technology in eUROp

The ARTURO (Advanced Radar Technologies in eUROpe) project proposes a solution to fulfil future operational needs based on extended use of emerging technologies. The ARTURO research addresses the future defence needs (keeping in mind civil world as well) and proposes a new class of sensors based on feasibility studies and high level specifications.
From an architectural point of view, the proposed approach is based on the scalability as a key driver of design, i.e. a modular design for extending the same components on different platforms with a consequent reduction of non recurring and logistic costs. The design is then based on an elementary and fundamental component for all the new classes of radars while the different sensors for different domain applications are formed via aggregation of the elementary component. As a matter of fact, the ARTURO project will analyse and study a wide set of technologies to evaluate the benefits they could bring in new generation of radar systems and to indicate which are relevant depending on the Concept of Operations (CONOPS). In particular, a roadmap for sensors will be elaborated based on the study results provided by various
technological analyses. This roadmap will figure out the most appropriate sensors according to their domain and use cases, their class of performance, their level of maturity, their cost benefit analysis, and their complementarity regarding other competing technologies.

Keywords: Radar, operational needs, technological roadmap

Technical Sheet
Funding institution:
EU EDF
Project partners
Scalinix, Sentech S.r.l., Thales DMS France SAS, Thales Nederland BV, Totalforsvarets Forskningsinstitut, Universidad de Sevilla, Università degli Studi di Pavia, XY-Sensing, Leonardo SpA, Aalto Korkeakoulusaatio sr, Airbus Defence and Space, Baltijos Pazangiu technologiju Institutas, CoreHW, Echoes S.r.l., Hensoldt, Indra, Marduk Technologies, TNO, Pitradwar, Rheinmetall Italia, SAAB, SATWAYS
Project duration
September 2023 - August 2026
Involved countries
Italy, France, Germany, Netherlands, Sweden, Spain, Poland, Finland, Lithuania, Estonia, Greece



(a) High Level Conceptand Logo of ARTURO.

PROJECT DEEP-TRACE

Deployable performing HF radio goniometer compact system for C-ESM applications

The DEEP-TRACE project aims at realizing a multi-channel system based on an array of compact receiving antennas for receiving, digitizing and analysing HF band signals for C-ESM applications. This configuration is conceived to cope with compactness, easy deployment, modularity, and scalability requirements.
The proposed technological solution allows to estimate the direction of arrival (DoA) of the received signals, to characterize the signal through the use of Artificial Intelligence (AI) techniques, and to localize the source making use of 3D ionospheric propagation models for the signals transmitted in sky-wave mode. This system could be used individually or in a multi-sensor / multi-platform configuration. This last configuration, appropriately dislocated, will allow the geolocation of the HF source, regardless of the type of propagation (sky-wave or surface-wave).
The main innovative aspects of this proposal are:

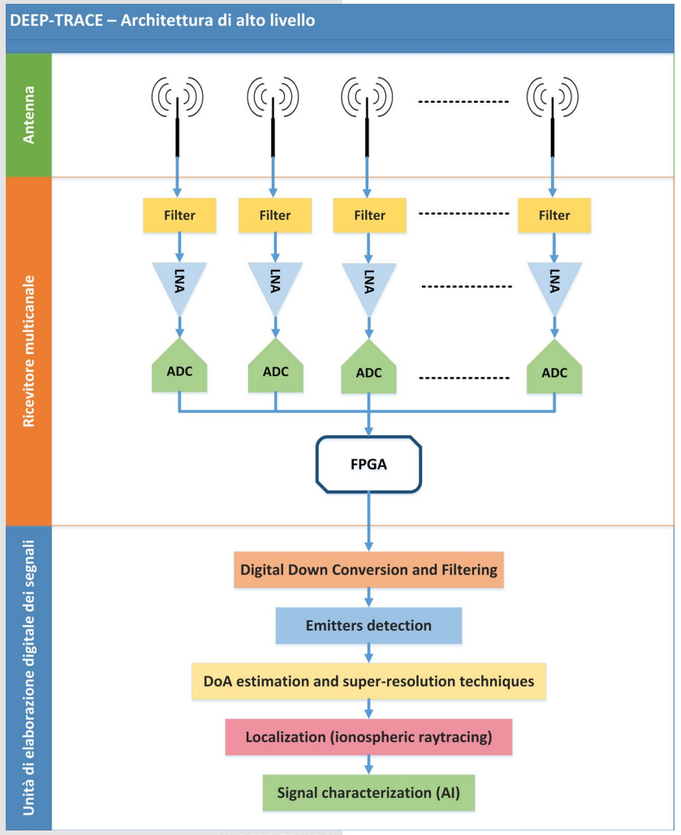
1) An accurate miniaturization of the antennas combined with the use of an active and flexible adaptation, able to use the radiating elements in array configuration to be deployed both in the terrestrial environment (urban or not) and naval;
2) Implementation of different DoA estimation techniques even in the presence of a limited number of sensors, and comparison of their performance in terms of mean square error of estimate and robustness to mismatches between design conditions and actual conditions determined by the ionospheric channel;
3) Positioning techniques of the individual receiving nodes in a sensor network configuration. The techniques adopted will optimize the spatial configuration of the nodes in order to minimize the Cramer-Rao limit on the DoA estimate.
4) Localization based on 3D ionospheric propagation models able to reconstruct the e.m. path from the receiver to the transmitter through the ionospheric channel;
5) Artificial Intelligence (AI) for classifying the detected signal (e.g.: type of propagation, continuous / pulsed wave, modulation, etc.).

The Deep Trace project has completed its second phase during which the subsystems have been tested separately. During the third phase the integration of the overall system and functional tests in operative scenario will be performed.

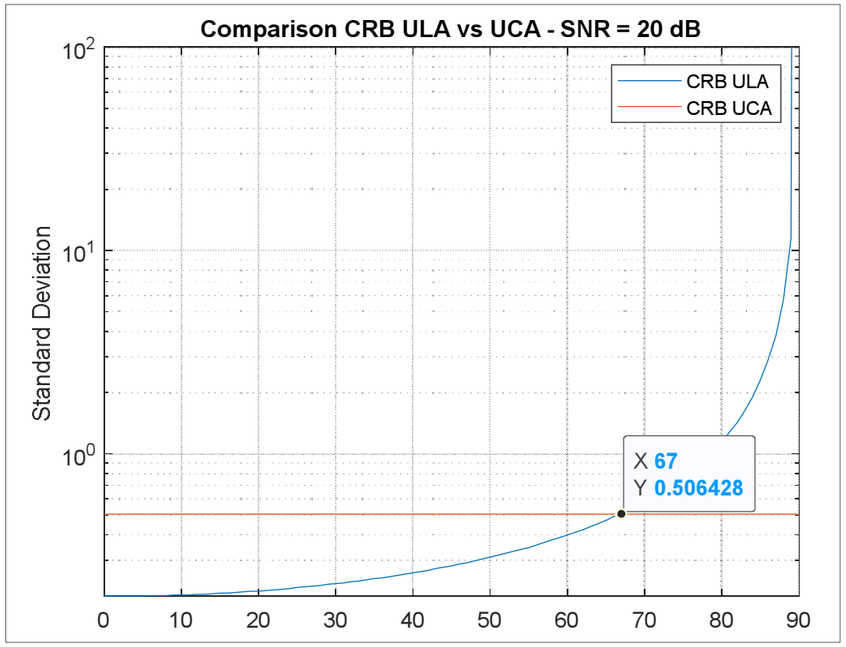
Keywords: HF communication, C-ESM, HF compact Antennas, Ionospheric study, Raytracing 3D, AI, Direction of Arrival (DoA), Single Site Location (SSL)

DEEP TRACE

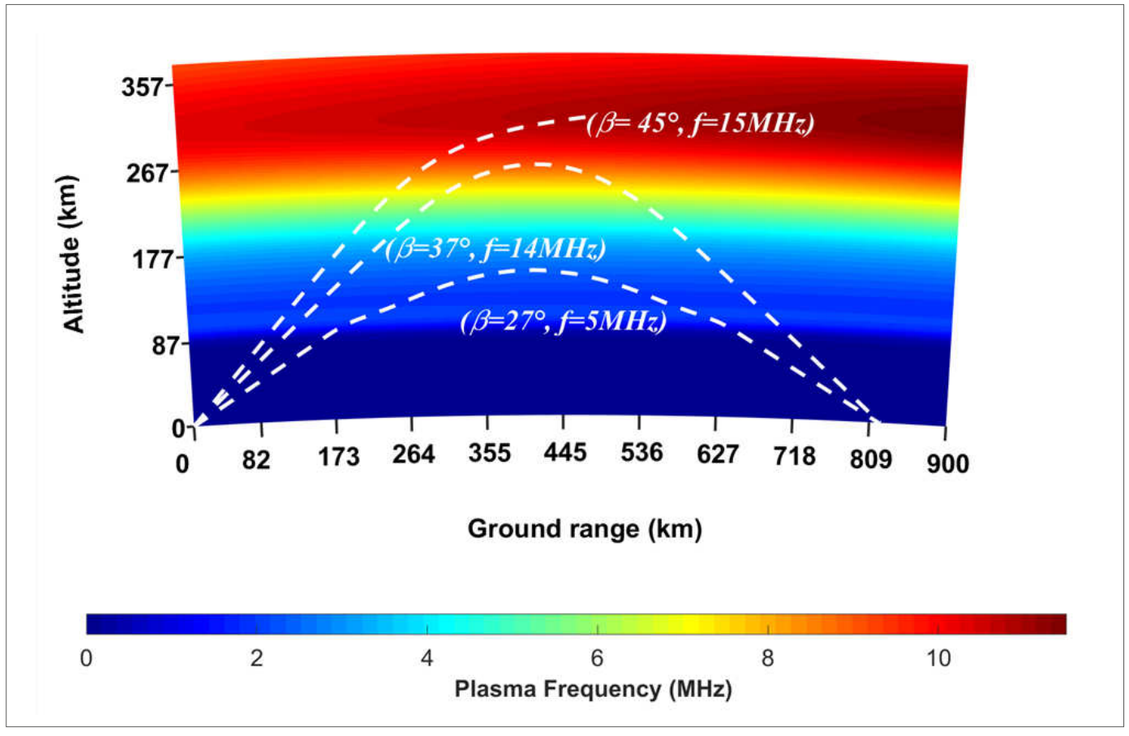
Technical Sheet
Funding institution:
Italian MoD
Project partners
ECHOES s.r.l., FreeSpace s.r.l
Project duration
June 2021 – June 2024
Involved countries
Italy



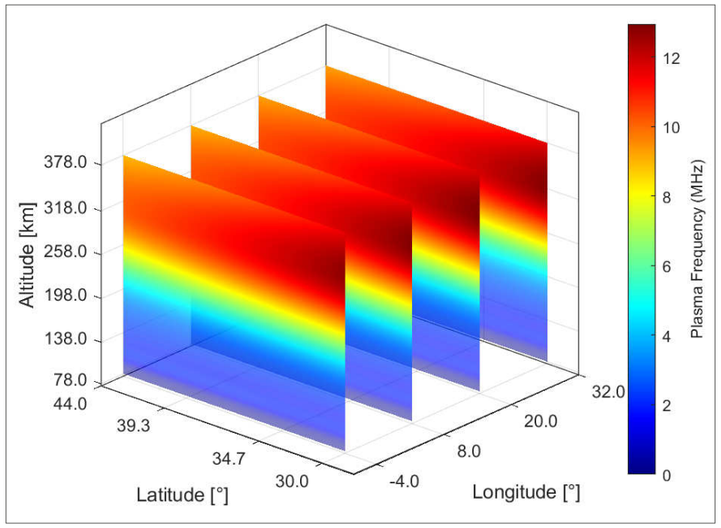
(a) DEEP-TRACE High-level architecture



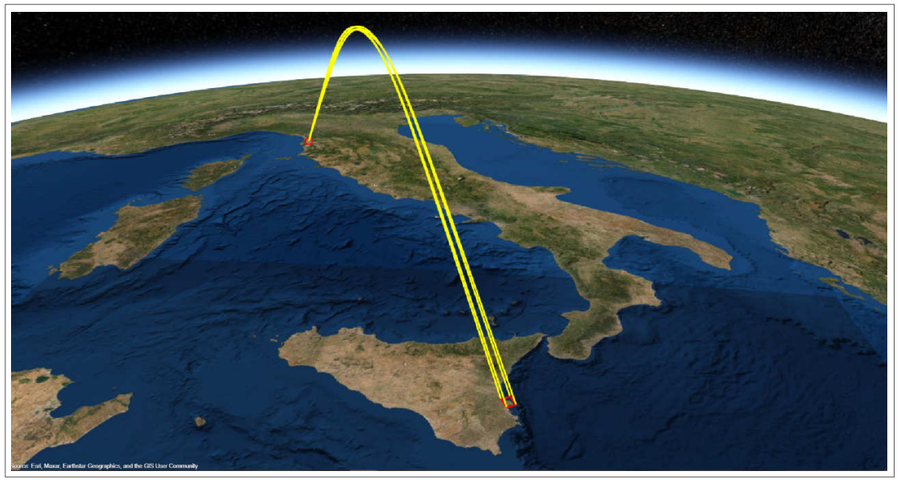
(b) Beamforming performance comparison: Uniform Linear Array (ULA) vs Uniform Circular Array (UCA) (SNR=20 dB)



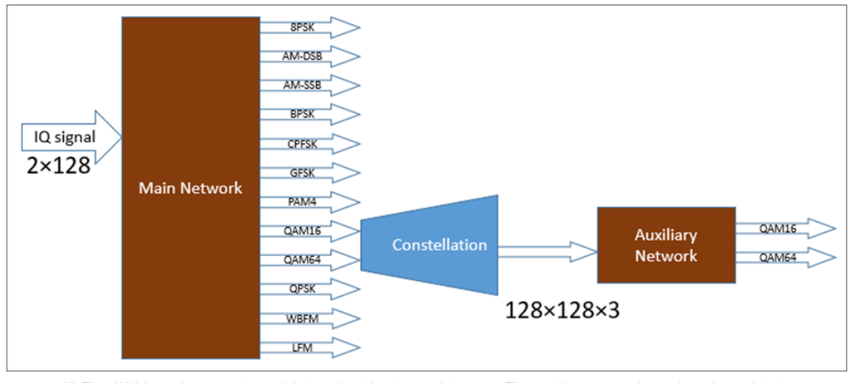
(c) Electron density profile and ray-paths formation related to the reference scenario



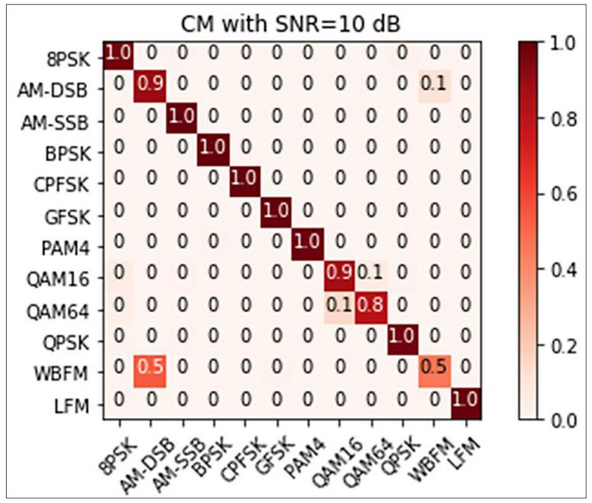
(d) Longitude slices of the 3D Electron density related to the reference scenario



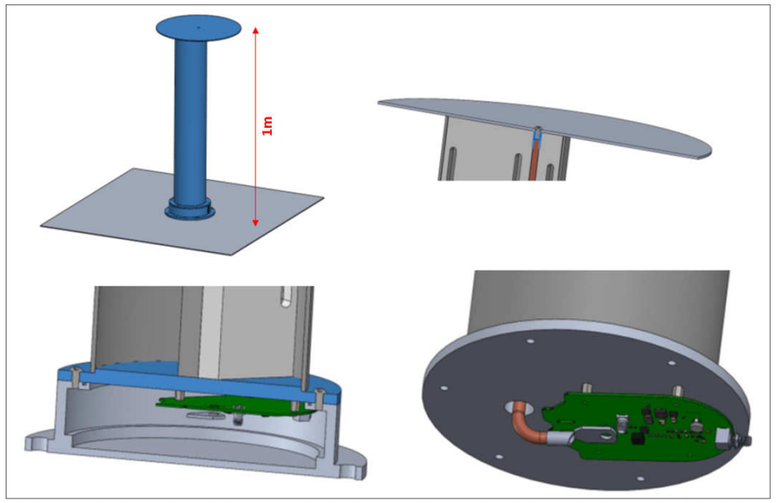
(e) 3D ray tracing outcome for the transmitter localization in the reference scenario



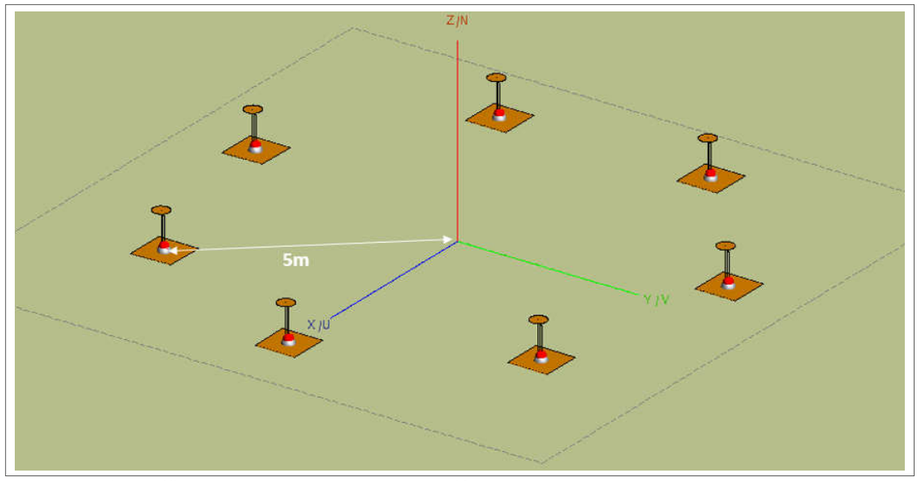
(f) The CNN-based automatic modulation classification architecture. The auxiliary network resolves the ambiguity between the two similar modulations (QAM16, QAM64) to enhance the overall accuracy



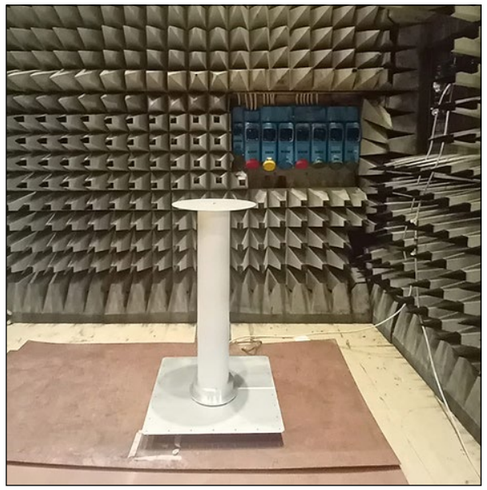
(g) The confusion matrix of the proposed automatic modulation classification architecture at SNR=10dB



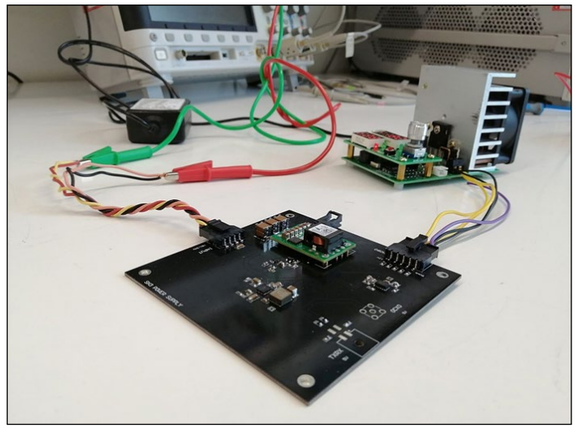
(h) Preliminary mechanical project of the antenna (single element of the array) including, at the bottom, the PCB of the amplifier performing the matching with the front-end of the receiver. The antenna is very compact having an overall dimension of about 1m



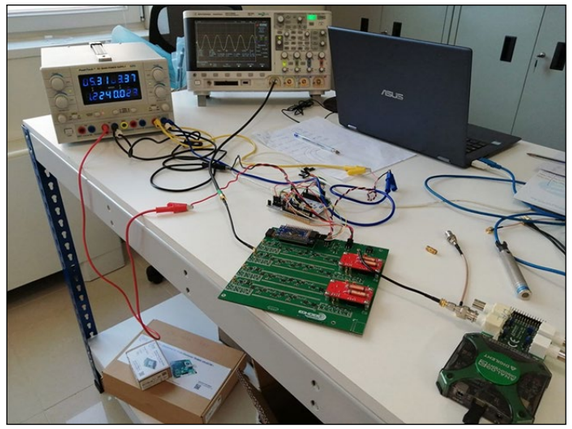
(i) EM model of the circular array for the DOA estimation. The array diameter is about 10m and it can be easily deployed in the operative scenario due to the compact antennas



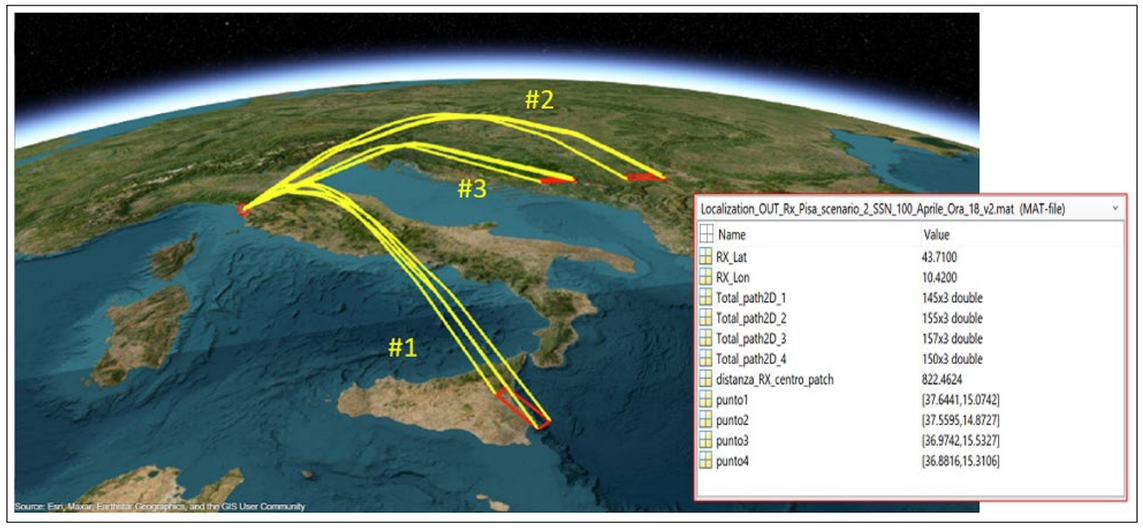
(l) antenna in the anechoic chambers for the test measurements (courtesy of Free Space S.r.l.)



(m) Measurement setup of the Power Supply Unit of the SDR receiver (courtesy of ECHOES S.r.l.)



(n) Setup test amplification chain (courtesy of ECHOES S.r.l.)



(o) Graphical and numerical output related to localization test.

PROJECT EO4SECURITY

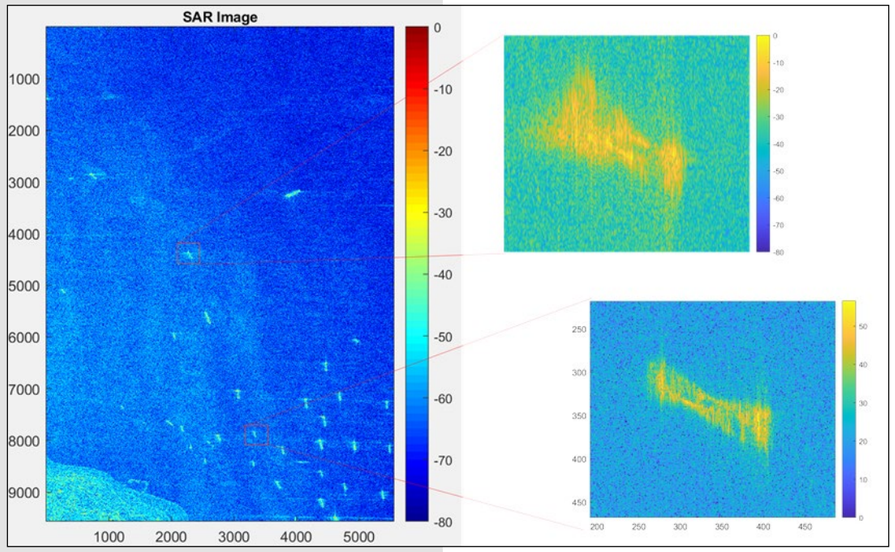
Innovative SAR processing methodologies for security applications

The project aims to design, implement, and verify an innovative solution utilizing ISAR (Inverse Synthetic Aperture Radar) technology to achieve detailed characterization of moving objects using spaceborne SAR (Synthetic Aperture Radar) data. It involves conducting an in-depth review of the current ISAR state-of-the-art (SOTAR), including preprocessing and post-processing steps, to clearly define its components and specifications.
A critical phase is the review of operational needs, collaborating with security, defense, and intelligence stakeholders to identify gaps in SOTAR and establish key parameters for use cases.
The project also focuses on selecting the most suitable algorithm, defining the validation methodology, and creating reference datasets to support its implementation, validation, and performance assessment. To deliver a complete solution, an end-to-end ISAR chain will be implemented and assessed, which includes algorithm deployment, integration into an operational value chain, execution of use cases, and the definition of a clear operational strategy.

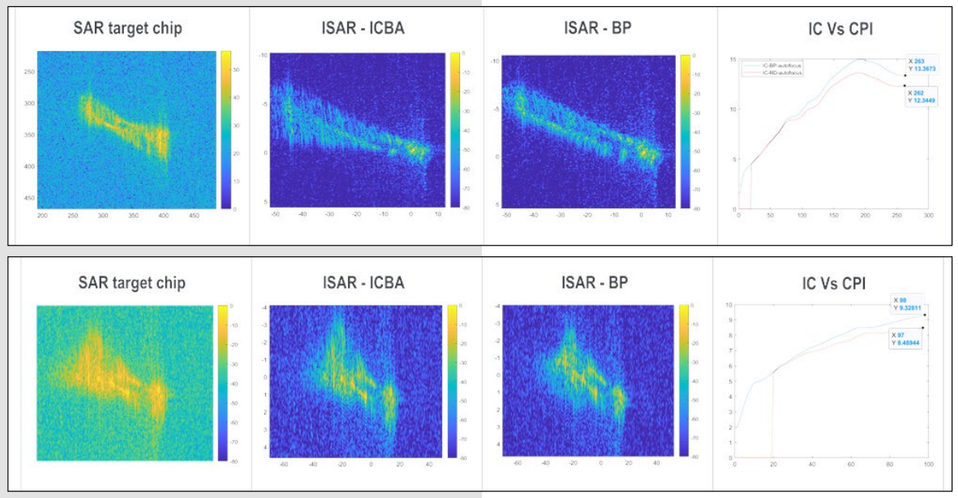
This approach ensures that the developed ISAR solution meets operational requirements, addresses technical challenges, and delivers validated performance for real-world applications in defense and security contexts.

Keywords: ISAR, SAR

Technical Sheet
Funding institution:
ESA
Project partners
E-GEOS, CNIT, Aresys
Project duration
September 2023 - September 2024
Involved countries
Italy



(a) Original SAR image and selected targets



(b) Analysis of the proposed approach onto two targets extracted from COSMO-SkyMed (CSK) SAR images.

PROJECT FARADAI

Frugal and Robust AI for Defence Advanced Intelligence

The project “Frugal and Robust AI for Defence Advanced Intelligence” (FaRADAI) focusses on frugal learning, i.e. the ability of a system to adapt and learn from its environment, including from user supervision, for a reasonable cost and without intervention from expert developers. An important cross-cutting need for Artificial Intelligence is to create technologies for reliable, autonomous, and frugal learning, i.e. the ability of a system to adapt and learn from its environment, including from user supervision, at a reasonable cost and without intervention of expert developers nor regression.

Such technologies can be highly disruptive and have a high impact on many capabilities, especially when the information to be managed is highly variable or unpredictable and high adaptability is required.

These technologies can also alleviate the current need to provide data to system developers to achieve improvements depending on that data, which can be critical when the data is sensitive, and is therefore critical for defense. They can improve technological independence more generally. Selected actions should include the organization of technology challenges that address well-defined objectives in order to initiate and drive progress towards addressing identified defense needs, while simultaneously leveraging civilian research and generating spillover effects.

As part of the FaRADAI project, current advances in artificial intelligence technologies will be thoroughly studied in parallel with a detailed study of the main challenges imposed by a defense system. Aiming for significant breakthroughs in artificial intelligence, the models will accelerate their wider application and deployment in defense systems, increasing their impact and overall performance.

Keywords: Target Classification, Artificial Intelligence

Technical Sheet

Funding institution:

EU EDF

FaRADAI has received funding from the European Union's EDF programme under grant agreement No 101103386.

Funded by the European Union

Project partners

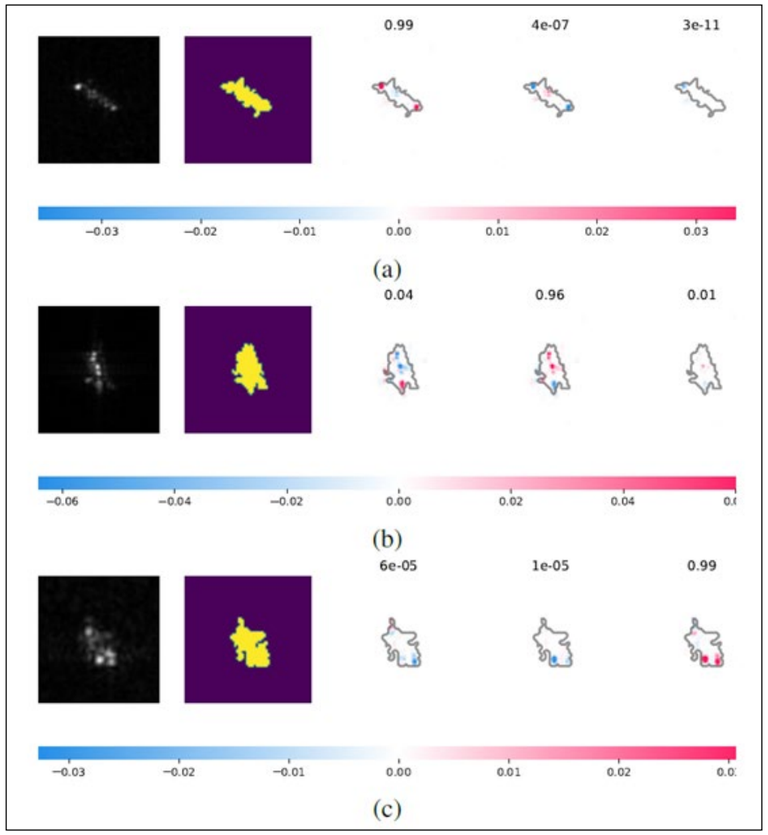
ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS, ANAPTYXIS - CERTH, BALTIJOS PAZANGIU TECHNOLOGIJU INSTITUTAS, BIANOR SERVICES EOOD, C&V CONSULTING, COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES, DEFSECINTEL SOLUTIONS OU, E-GEOS SPA, EXUS SOFTWARE MONOPROSOPI ETAIRIA, PERIORISMENIS EVTHINIS, FLYSIGHT SRL, FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER, ANGEWANDTEN FORSCHUNG E.V., FUNDACION TECNALIA RESEARCH & INNOVATION, HENSOLDT OPTRONICS GMBH, INDRA SISTEMAS SA, INFILI TECHNOLOGIES SOCIETE ANONYME, INSTITUT PO OTBRANA, LEONARDO - S.p.A., LINK CAMPUS UNIVERSITY, MARINTRAFIK OPEREISONS ANONYMI, ETAIREIA PLIROFORIKIS, MBDA ITALIA S.p.A., NATIONAL CENTER FOR SCIENTIFIC, RESEARCH “DEMOKRITOS”, NAVAL GROUP, NEDERLANDSE ORGANISATIE VOOR TOEGEPAST, NATUURWETENSCHAPPELIJK ONDERZOEK TNO, OKTAL SYNTHETIC ENVIRONMENT, RHEINMETALL ELECTRONICS GMBH, RIGAS TEHNISKA UNIVERSITATE, SAFRAN ELECTRONICS & DEFENSE, SATWAYS, SKA POLSKA SPOLKA Z OGRANICZONA, ODPOWIEDZIALNO, STAM SRL, SZAMITASTECHNIKAI ES AUTOMATIZALASI KUTATOINTEZET, THALES France, THALES PROGRAMAS DE ELECTRONICA Y COMUNICACIONES SA, THALES SIX GTS FRANCE SAS, UNIVERSIDAD POLITECNICA DE MADRID

Project duration

December 2022 - August 2026

Involved countries

Lithuania, Bulgaria, Belgium, Estonia, Germany, Spain, Greece, France, Netherlands, Latvia, Poland, Italy, Hungary

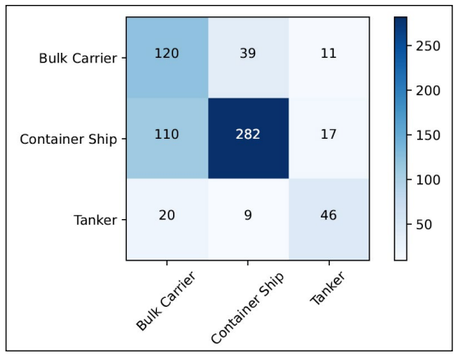


(a) SHAP output for class 0 (a), class 1 (b), and class 2 (c)

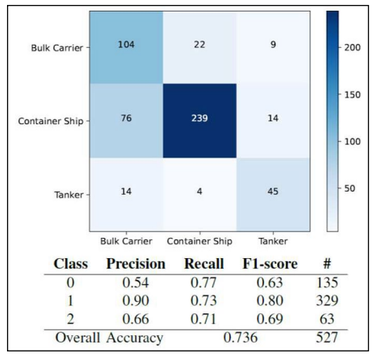
Class metric scores

	s_0	s_1	s_2	r
(a)	**0.65**	-0.37	-0.28	1
(b)	-0.28	**0.57**	-0.28	1
(c)	-0.35	-0.37	**0.73**	1

(b) The classification reliability metric (r) computed for the examples depicted in (a)(c) Confusion matrices before (a) and after (b) pruning unreliable predictions using SHAP



(c) Confusion matix before pruning predictions using SHAP



Class	Precision	Recall	F1-score	#
0	0.54	0.77	0.63	135
1	0.90	0.73	0.80	329
2	0.66	0.71	0.69	63
Overall Accuracy			0.736	527

(d) Confusion matix after pruning predictions using SHAP

PROJECT iFURTHER

High FreqUency oveR The Horizon sensors' cognitivE networRk

iFURTHER

The iFURTHER project aims to address wide area air and sea covert surveillance, by developing new concepts of Over-The-Horizon radar to be integrated into a collaborative network of high-frequency sensors. This project will therefore focus on a cognitive network of high-frequency radars as a disruptive future defence capability to protect the EU. The main objectives of this project are:

- Detect and track air and sea targets at long range (over the horizon), far beyond currently existing systems, by using the reflections of skywave and surface-wave propagated signals.
- Fill gaps and extend the current EU air and sea radar coverage by introducing a multistatic sensor configuration supported by ad-hoc network protocols and an appropriate infrastructure for synchronisation and coordination of sensors (e.g., Command and Control).
- Implement cognitive radar management systems to optimise operational parameters in real time and as a function of environmental conditions (e.g., the state of the ionosphere), based on robust ionospheric models and sounding protocols (not excluding the development of ionospheric sensors).
- Implement advanced signal processing techniques to improve over-the-horizon detection and track performance as well as target localisation capabilities.
- Utilize available non cooperative illumination and apply cognitive features at network level to develop new techniques for optimized use of the electromagnetic spectrum and passive processing.

Keywords: Target Classification, Artificial Intelligence

Technical Sheet

Funding institution:

iFURTHER is a research project funded by the European Defence Fund under EDF-2021-DIS-RDIS-OTHR-2 "Research for disruptive technologies for defence applications" - Grant Agreement No. 101103607

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Project partners

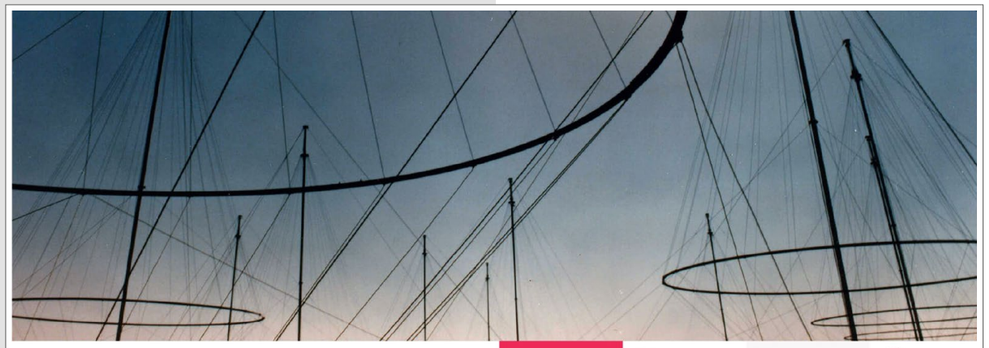
Hellenic Aerospace Industry SA, Office National D'etudes Et De Recherches Aerospatiales, Ethniko Asteroskopeio Athinon, Imatik - Efarmoges Ypsilis Texnologias Etaireia Periorismenis Efthinis, Consorzio Nazionale Interuniversitario per le Telecomunicazioni, Istituto Nazionale di Geofisica e Vulcanologia, Politechnika Warszawska, Fraunhofer Gesellschaft Zur Foerderung Der Angewandten Forschung E.V., Helzel Messtechnik GmbH, Technisch-Mathematische Studiengesellschaft Mit Beschrankter Haftung, Indra Sistemas SA, Universidad De Alcala, SignalGenerix Limited, Patria Aviation Oy, Era AS, Ministry Of National Defence, Greece, L - up SAS

Project duration

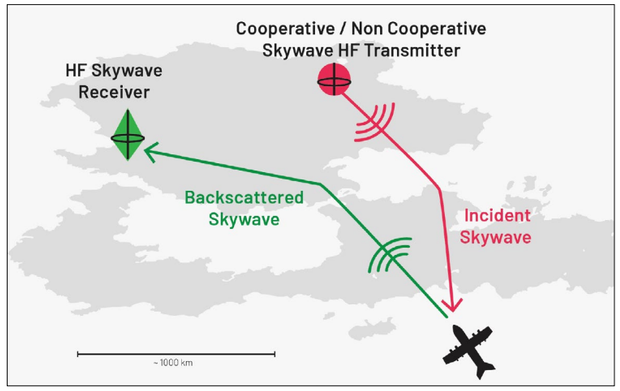
December 2022 - November 2025

Involved countries

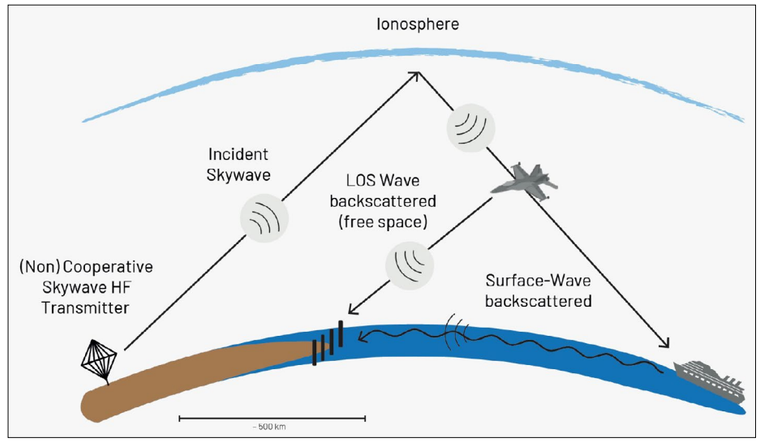
Italy, Greece, Germany, Czech Republic, Spain, France, Finland, Poland, Cyprus



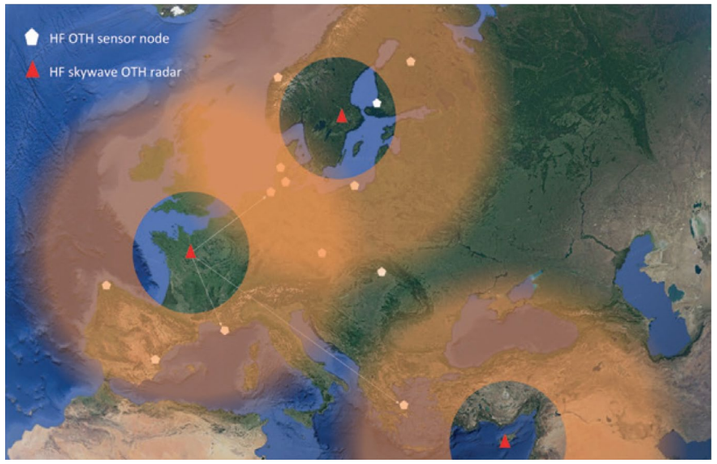
(a) iFURTHER overview



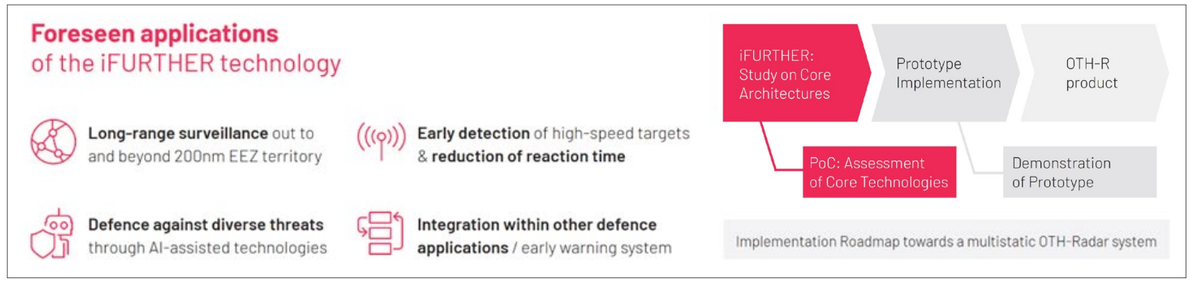
(b) Multistatic Skywave OTH-R system with long baseline: Concept



(c) Multistatic Hybrid (Skywave - LOS/Surface-wave) OTH-R system: Concept



(d) Envisioned EU wide surveillance



(e) Foreseen applications and implementation roadmap towards an OTH radar product

PROJECT ISS

Integrated Submarine System

The aim of this project is to analyse the technological and algorithmic solutions for a Target Motion Analysis (TMA) system for submarines. Particularly, a software-defined architecture is proposed to host a wide spectrum of software applications dedicated to the management of on-board systems. Using a distributed shared server architecture, data can be available from multiple users at the same time, without the need of execution on dedicated consoles. The proposed architectural approach allows to limit the space required for the HW, for which an architecture has been proposed, introducing energy saving factors and minimizing the need for heat dissipation. The modularity of the architecture makes it easy to integrate possible updates both HW (to increase system computational capabilities) and SW (to update automatic information analysis capabilities) and ensure interoperability with solutions from any future developments.
Given the software-defined nature of the system, a particular focus has been the cybersecurity aspects, adopting a security-by-design strategy, which provides the integration of special security systems in each element of the developed system.
In addition, advanced artificial intelligence algorithms were taken into account to allow the identification and mitigation of any cyber attacks. Finally, TMA and data fusion algorithms have been analysed, focusing on the integration of different types of sensors in the system without the need to modify the software.

Keywords: Submarine Tracking, Target Motion Analysis (TMA), Cyber Security, Passive Sonar.

Technical Sheet
Funding institution:
DRASS
Project partners
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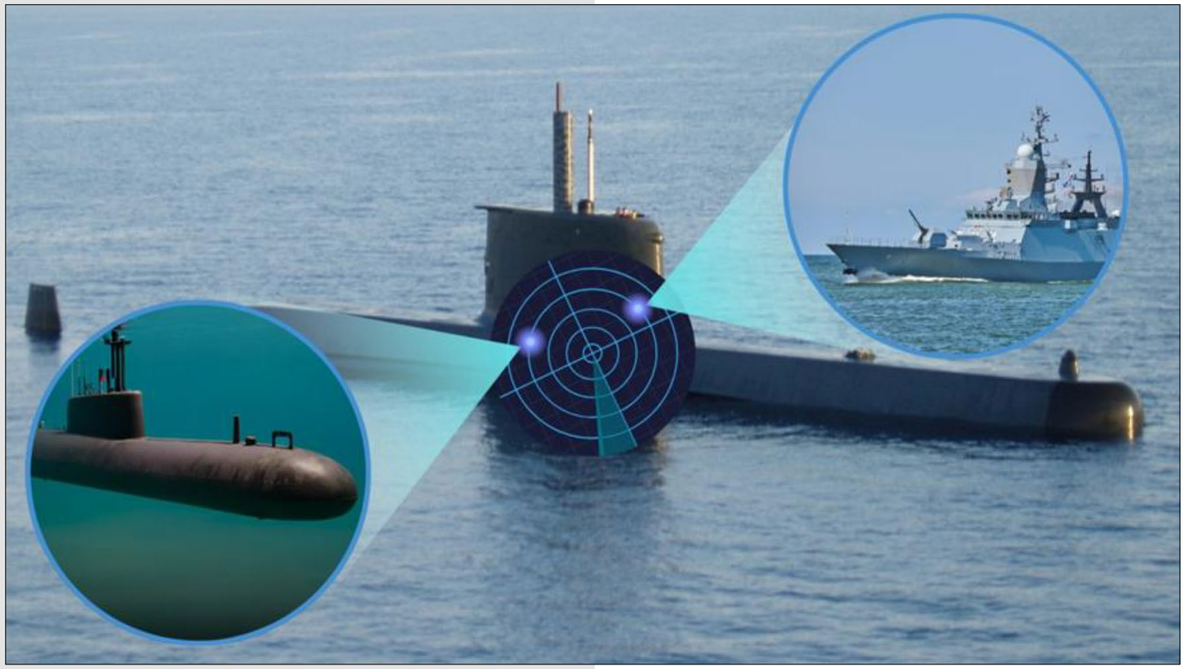
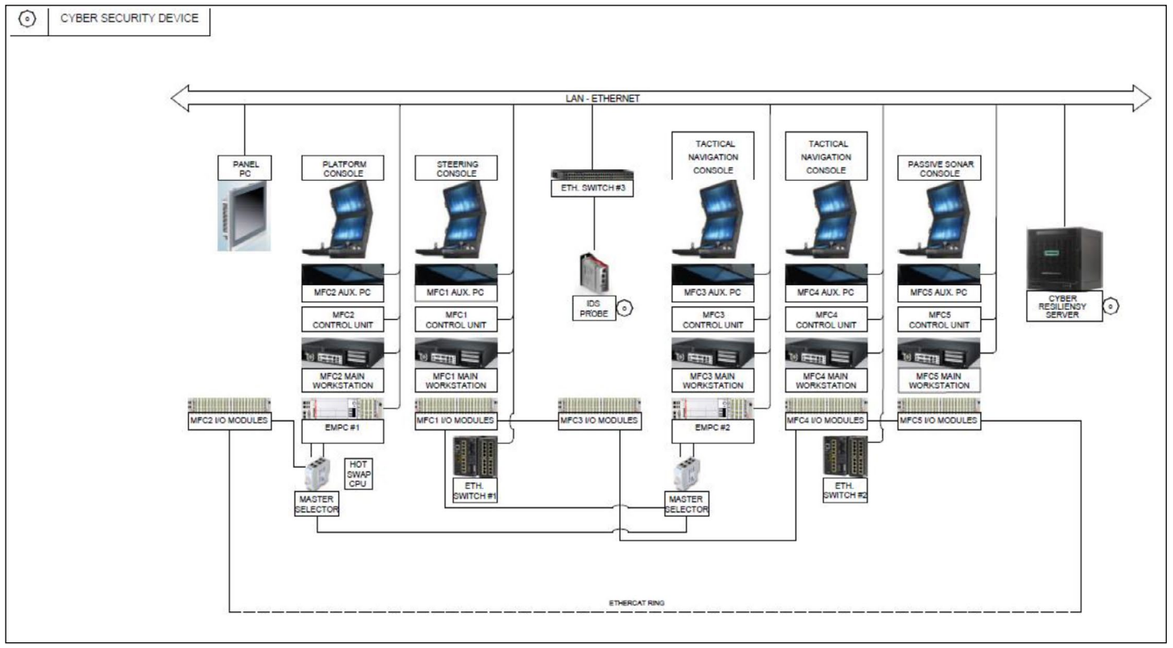
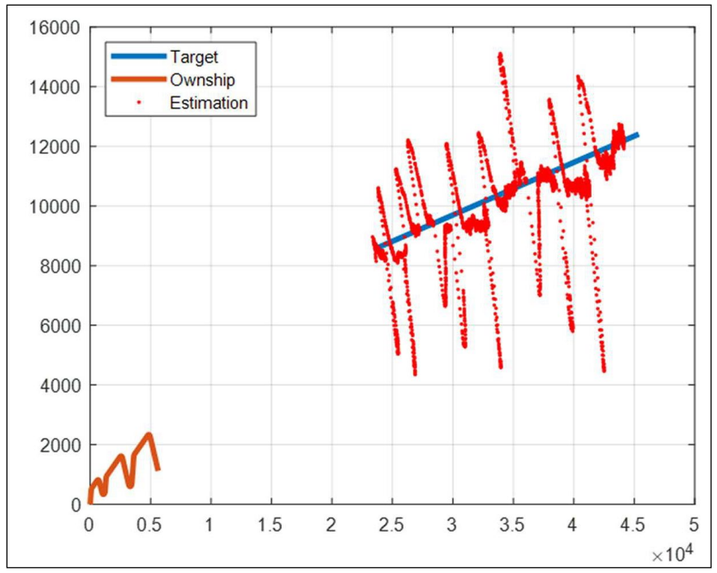
Project duration
January 2021 - October 2023
Involved countries
Italy



(a) The system will track both surface and underwater targets



(b) Possible hardware configuration of a command and control system



(c) TMA simulation results.

PROJECT LEO-TO-VLEO

Mission driven LEO to VLEO satellites for defence operations

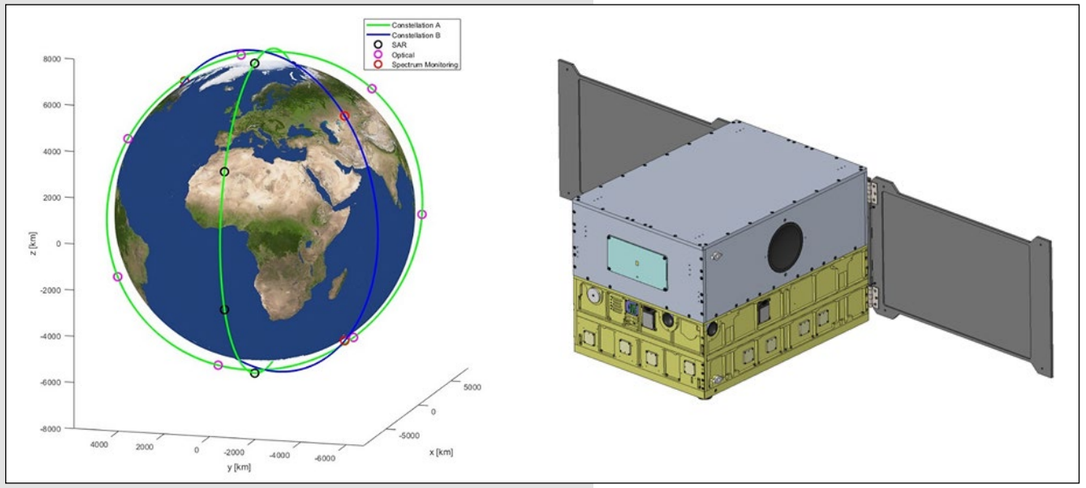
The main objectives of this project focus on developing a comprehensive business case for the use of Low Earth Orbit (LEO) to Very Low Earth Orbit (VLEO) satellites in military applications, emphasizing their feasibility, benefits, and challenges. The LEO-to-VLEO system operates in a dual-mode configuration: satellites maintain functionality in a low altitude parking orbit within LEO for routine operations and descend to VLEO under conditions demanding enhanced performance. This transition allows for superior resolution and improved sensor capabilities in critical scenarios.

The project seeks to define precise technical requirements for satellite design, covering aspects such as spatial and temporal coverage, sensor capabilities, communication quality, security, and interoperability to ensure alignment with military needs.

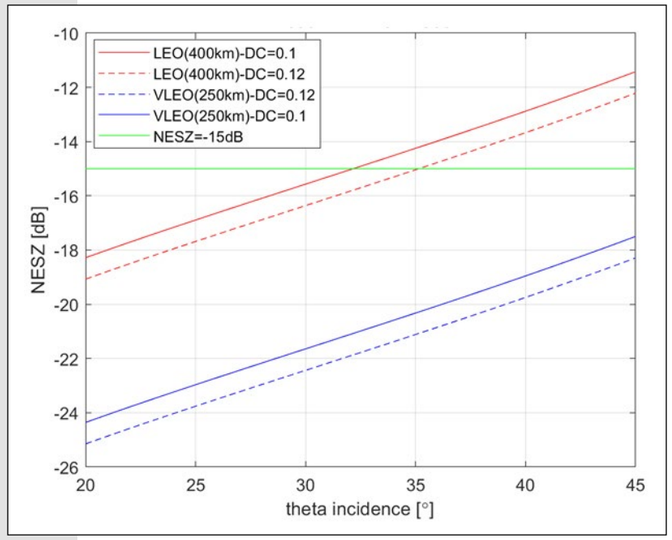
A preliminary design phase is also included, involving the creation of preliminary architectural specifications, 3D models, and full-scale mock-ups to validate design feasibility and optimize system efficiency. Additionally, the project prioritizes European non-dependence on critical components and technologies, addressing risks associated with external dependencies and fostering strategic autonomy. Beyond technical milestones, this initiative aims to enhance European leadership in space technology, contributing to its defence capabilities, resilience, and sovereignty in a competitive global landscape.

Keywords: Satellite and payload design, CONOPS, propulsion system.

Technical Sheet
Funding institution:
EDA
Project partners
TYVAK International, Politecnico di Milano, FlySight
Project duration
March 2024 - March 2025
Involved countries
Italy



(a) Satellite constellation (from PoliMi) satellite bus (NEBULA from Tyvak)



(b) SAR payload preliminary performance (NESZ) comparing VLEO and LEO orbits

PROJECT PESCO

PErvaSive Communications - RESTART
Spoke 1 on Pervasive and Photonic
Network Technologies and Infrastructures

The Future Pervasive Internet will be an extremely complex environment, where communication and sensing functions will be integrated exploiting a multitude of complementary enabling technologies, and where functionalities will also be embedded into (beyond-edge) users and IoT devices, which will become an integral part of the pervasive network. Addressing this vision, PESCO sets itself at one of the strategic crossroads for the development of beyond-5G and 6G networks, also integrating future generation sensing components in a holistic way. PESCO addresses the complexity of the research challenges posed by this scenario in a comprehensive way, involving a multiplicity of key expertises. Based on a comprehensive architecture, PESCO will deliver the critical components in the fundamental areas of: (i) novel user-centric pervasive Internet paradigms including IoT and users' devices; (ii) integrated sensing and communication technologies; (iii) edge intelligence supporting pervasive environments; (iv) novel sensing paradigms exploiting diverse communication technologies; (v) holistic sensing and communication cognitive approaches taking into account broader environmental aspects, like, for instance, energy efficiency. PESCO implements a multi-faceted performance evaluation approach, composed of a blend of analytical modelling, large-scale simulation and prototyping, to deliver key results in the aforementioned areas. CNIT RaSS Lab activity is focused on the study of the synchronization requirements for radar MIMO system on drone swarm, on the synchronization technique integration and on the experimental test/validation. Detect and track air and sea targets at long range (over the horizon), far beyond currently existing systems, by using the reflections of skywave and surface-wave propagated signals.

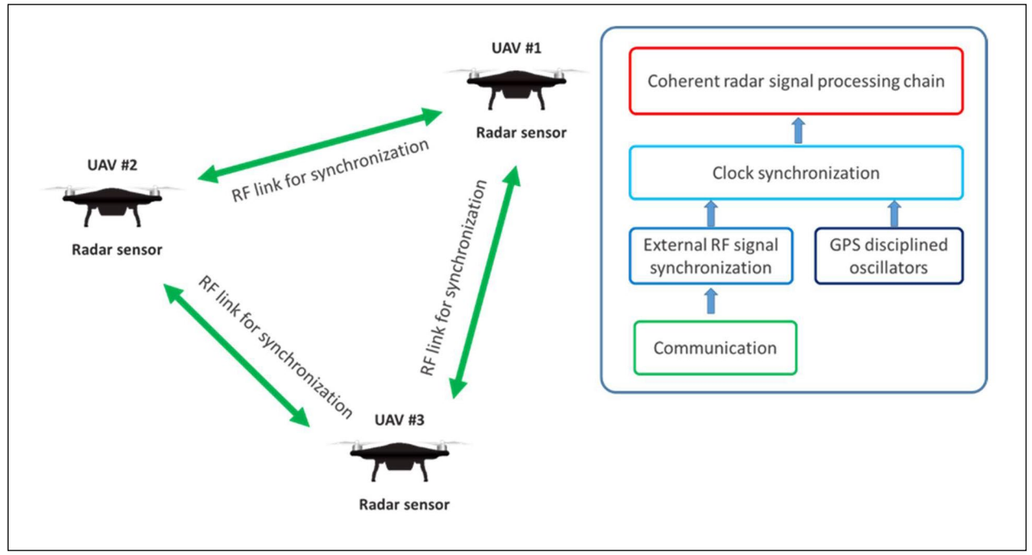
Keywords: Radar systems, Radar signal processing.

RESTART PESCO

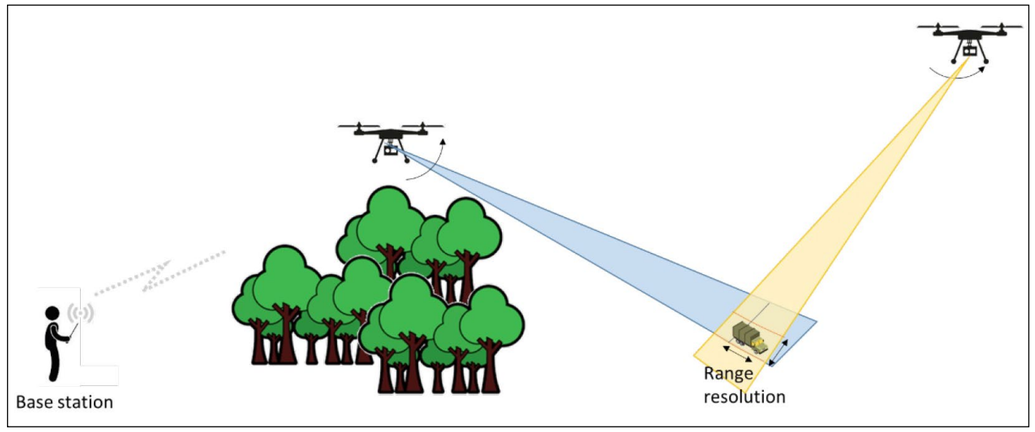
Funded by the European Union NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani

Technical Sheet
Funding institution:
European Union under the Italian National Recovery and Resilience Plan (NRRP) of NextGenerationEU
Project partners
CNR IIT, CNR IEIIT, CNR IREA, UniFI, UniPI, IniPD, UniBO, CNIT PNT Lab, OpenFiber
Project duration
January 2023 - December 2025
Involved countries
Italy

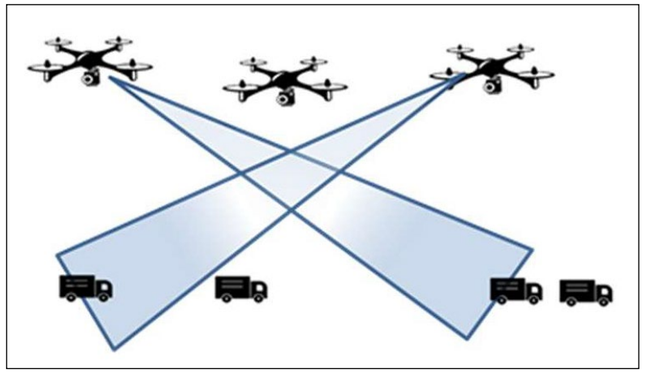
(a) Swarm of drones synchronization conceptual image



(b) Logical architecture of the use case related to the swarm of drones synchronization



(c) Swarm of drones reference scenarios: scenario 1 - detection and localization of moving targets



(d) Swarm of drones reference scenarios: scenario 2 - multistatic radar imaging.

PROJECT QUANDO SC3

QUANtum technologies for Defence with application to Optronics

Quantum sensors harness fundamental quantum principles like superposition and entanglement to approach the inherent measurement limits set by physics. They promise significantly enhanced precision and accuracy, revolutionizing scientific, industrial, and commercial applications. These sensors excel in measuring various physical quantities-magnetic, electric, and gravitational fields, times, frequencies, temperatures, and pressures-with unparalleled accuracy.

Typically, a quantum sensor employs discrete quantum states (qubits) dependent on the parameter being measured. A protocol initializes the system in a known quantum state, interacts it with the measured system, and measures the qubits. This iterative process significantly improves accuracy compared to traditional sensors by utilizing entanglement techniques, quantum control, or squeezing protocols that surpass the Heisenberg limit.

Quantum sensor advancements are poised to transform defence domains like C4ISR and navigation, with the potential to disrupt defense operations. The QUANDO Consortium, under EDA's directive, investigates quantum technologies for defense, focusing on quantum sensing. Collaborators across research organizations, large industrial partners, and SMEs are involved in this initiative, investigating quantum technologies' potential in optronics and radio frequency domains.

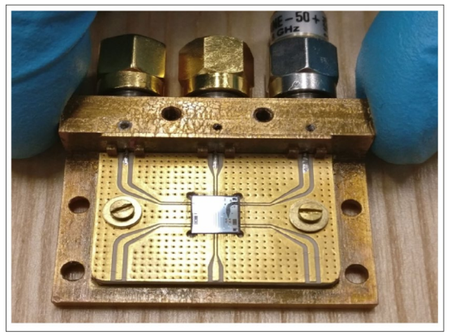
The current phase aims to synthesize an Electro Optical/Radio Frequency (EO/RF) quantum technology to solidify earlier studies and outline a potential EU defense quantum sensing roadmap. The project's objectives encompass technology identification, demonstrator design, realization, experimental testing, and result analysis, aligning with EDA's directive for an EO/RF quantum sensing proof-of-concept demonstrator.

The project evaluates EO and RF quantum sensing technologies, exploring non-classical light sources, Optical Parametric Oscillators for mid-IR radiation, cryogenic Josephson Parametric Amplifiers, and Nitrogen-Vacancy centers in diamond for compact antenna receivers. Quantum Radar, utilizing quantum properties to enhance signal processing and counteract stealth properties, stands as a promising technology offering superior target detection capabilities and resilience against electronic countermeasures.

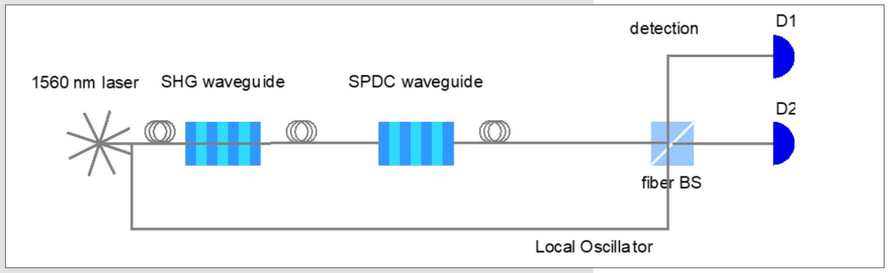
Keywords: Quantum Radar, Quantum Sensing

[1] D. Luong, C. W. S. Chang, A. M. Vadiraj, A. Damini, C. M. Wilson and B. Balaji, "Receiver Operating Characteristics for a Prototype Quantum Two-Mode Squeezing Radar," in IEEE Transactions on Aerospace and Electronic Systems, vol. 56, no. 3, pp. 2041-2060, June 2020

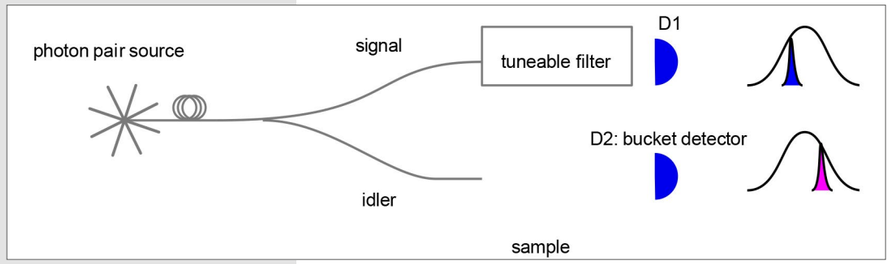
Technical Sheet
Funding institution:
EDA
Project partners
CNR, FLYBY S.R.L., LEONARDO S.P.A., TECNOBIT, THALES R&T, DLR
Project duration
December 2022 - December 2023
Involved countries
Italy, France, Germany, Spain



(a) Josephson Parametric Amplifier [1]



(b) Demonstrator components



(c) Demonstrator high-level scheme

PROJECT REACT II

Responsive Electronic Attack for Cooperation Tasks II

In the context of the fast-changing electromagnetic warfare environment and given the rapid advance in sensors and long-range weapons to counter air threats, it arises the urgent need to address the current military capabilities shortcomings of the EU MS in the area of Airborne Electronic Attack (AEA).

In order to deal with current and future contested EW environments, where the use of air power may be seriously compromised, it is required to boost a joint effort of the EU industry in the defence sector to fill in the gaps in the existing EU AEA capabilities.

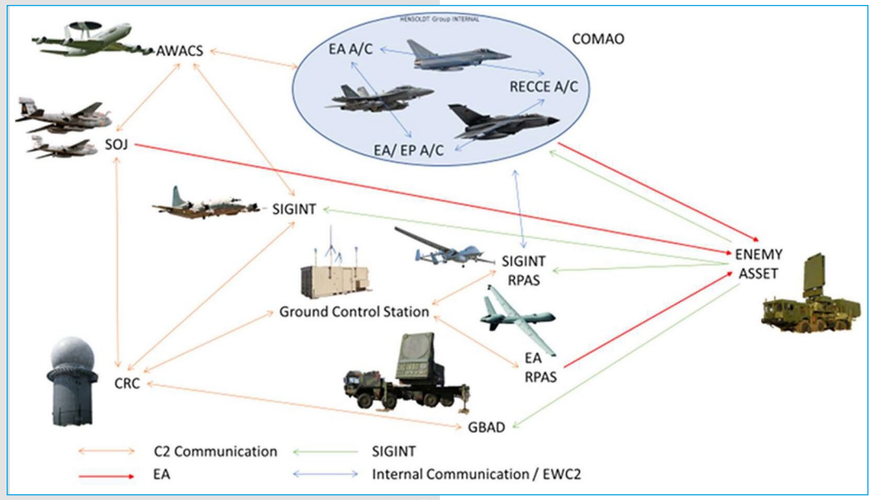
REACT II (awarded proposal for EDF-2022-DA-AIR-AEW) will bring all the progress made and the lessons learned from REACT I (awarded proposal for EDIDP-ACC-AEAC-2019). All this experience gathered is an invaluable asset to build on for the new project to be undertaken.

The REACT II consortium consists of 21 partners from 10 Countries, covering the whole value chain from applied research to high technology product development and supply.

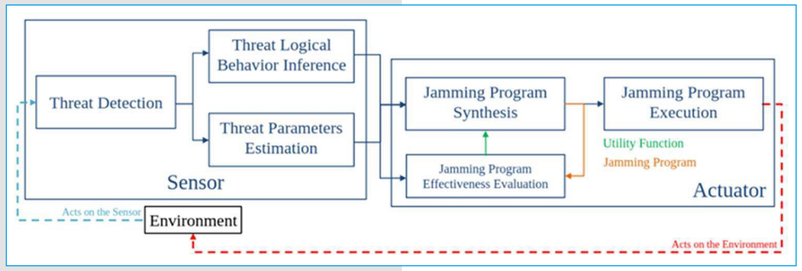
The REACT II solution to cover the future challenges for AEA capability will be comprised by a modular architecture based system whose core building blocks will allow to reconfigure the system to better adapt to the needs of the mission to be performed. From a strategic point of view, REACT II will encourage the cooperation among European Union member states, stimulating the production of doctrine and CONOPS at EU level, strengthening the EU defence own capabilities, promoting EU technologies and improving the competitiveness of EU defence industrial base to develop new EW systems to be offered as in-kind contribution to NATO defence.

Keywords: AESA, ECM, AI, Cognitive Radar.

Technical Sheet
Funding institution:
Co-funded by the European Union
Project partners
Indra (Coordinator, Spain), Elettronica (ELT, Italy), Hensoldt (HEN, Germany), Saab (SAAB, Sweden), Thales (TSA, France), CAFA Tech (CAFA, Estonia), BPTI (Lithuania), Rantelon (RAN, Estonia), Bianor Services (BIA, Bulgaria), XY Sensing (XYS, Poland), Axter Aerospace (AXT, Spain), Spikatech (SPT, Spain), Sentech (SEN, Italy), D&P Development (D&P, Italy), Warsaw University of Technology (WUT, Poland), Universidad Politécnica de Madrid (UPM, Spain), Royal Netherland Aerospace Center (NLR, Netherlands), Royal Institute of Technology in Stockholm (KTH, Sweden).
Project duration
December 2023 - November 2027
Involved countries
Spain, Italy, Germany, Sweden, France, Lithuania, Netherlands, Poland, Estonia, Bulgaria



(a) AEA network



(b) Cognitive EW system, block scheme.

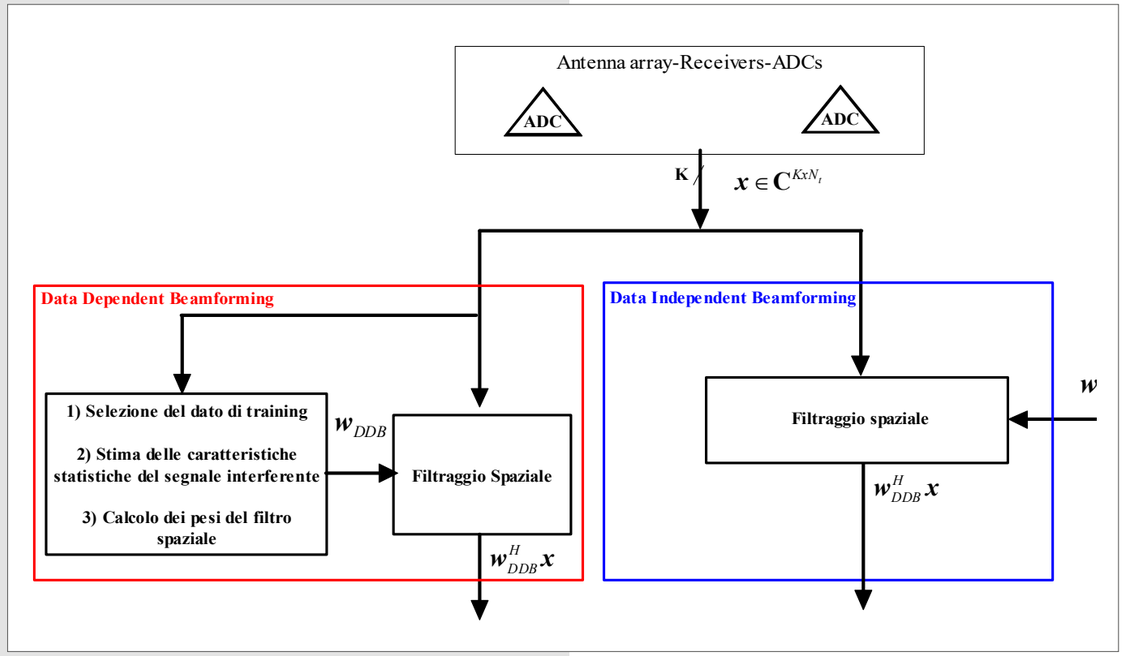
PROJECT SAMBA-X

Seeker AESA multiruolo a basso costo in banda X per applicazioni navali

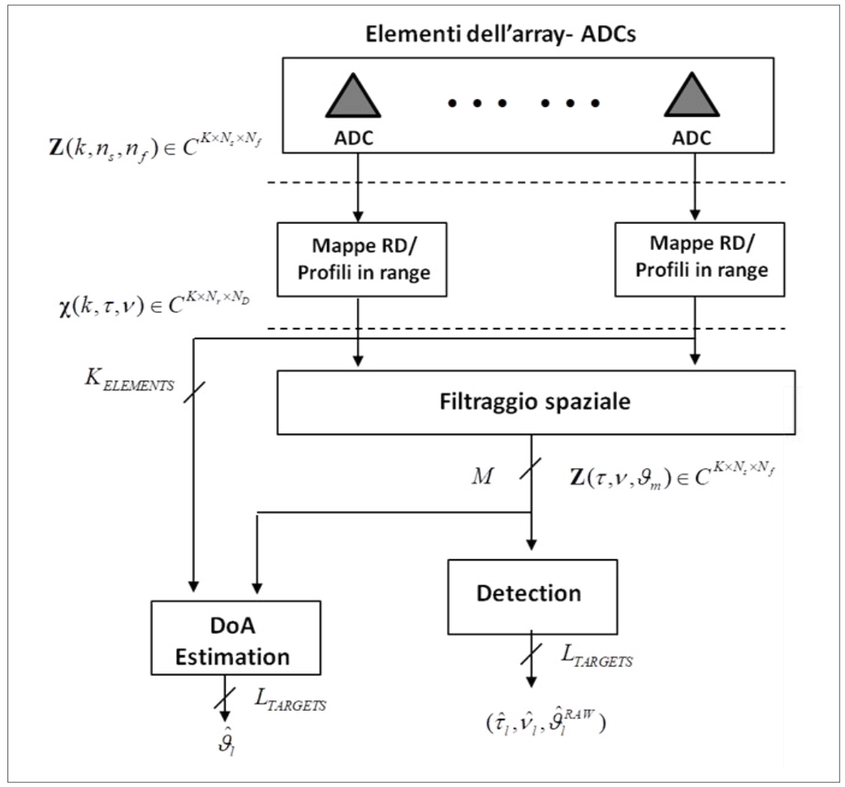
Traditional seekers use a mechanical scanning antenna, which limits the overall system performance. With the improvement of the latest microwave device technologies, Active Electronic Scanned Array (AESA) has become implementable in seekers. This allows for substantial performance improvements, which result in a significant increase of seeker's operational capabilities. In particular, SAMBA-X aims to improve seeker's performances with regard to increased target discrimination, resistance to ECM (ECCM), and greater longevity, thanks to the improved Mean Time Between Failures (MTBF) obtainable with this technology.
In summary, this project focuses on the study and development, for the first time in Italy, of a low-cost seeker demonstrator equipped with an ITAR-free AESA X-band antenna. The seeker under consideration has multirole capabilities, that is, it could also be used as a fire direction system on smaller ships. As part of this project, a demonstrator based on AESA technology will be built and validated in laboratory. Such demonstrator will implement a digital version of the classic "monopulse".
The demonstrator will also be able to record "raw" data and make it available for offline verification of newly developed algorithms. Once validated, these algorithms will be available for future implementations (upgrades) either on the same demonstrator or on a possible, higher TRL, prototype. During 2024 CNIT contributed also in user requirement definition and project validation.

Keywords: Seeker, Digital Beamforming, Jammer, Monopulse, AESA

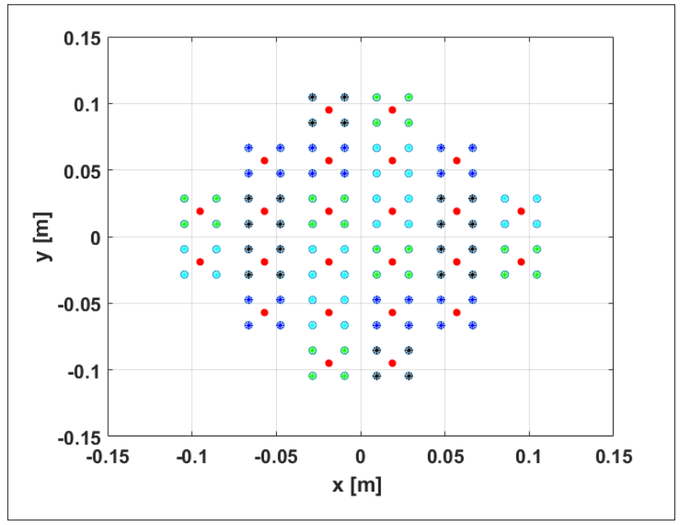
Technical Sheet
Funding institution:
Italian MoD
Project partners
ELDES S.r.l
Project duration
February 2020 - Ongoing
Involved countries
Italy



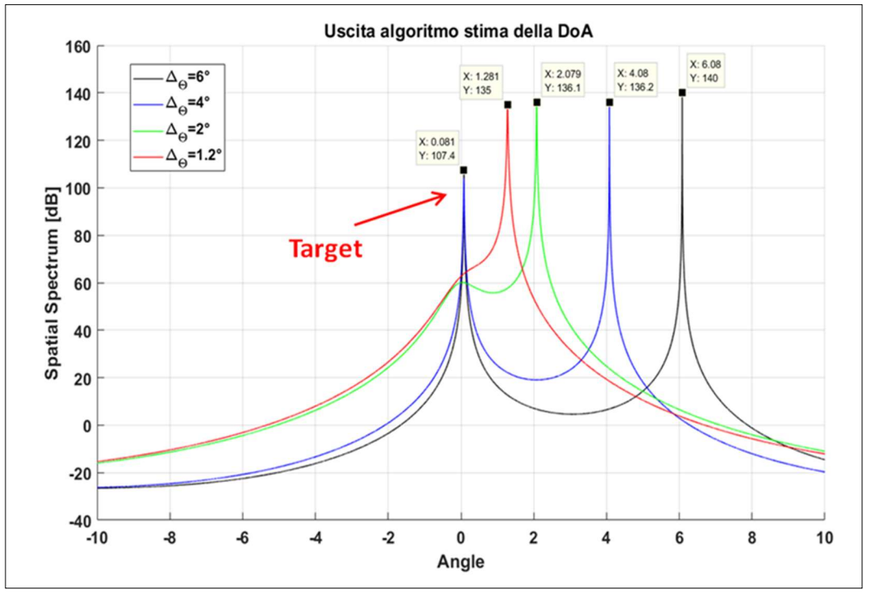
(a) Difference between data dependent beamforming and data independent beamforming



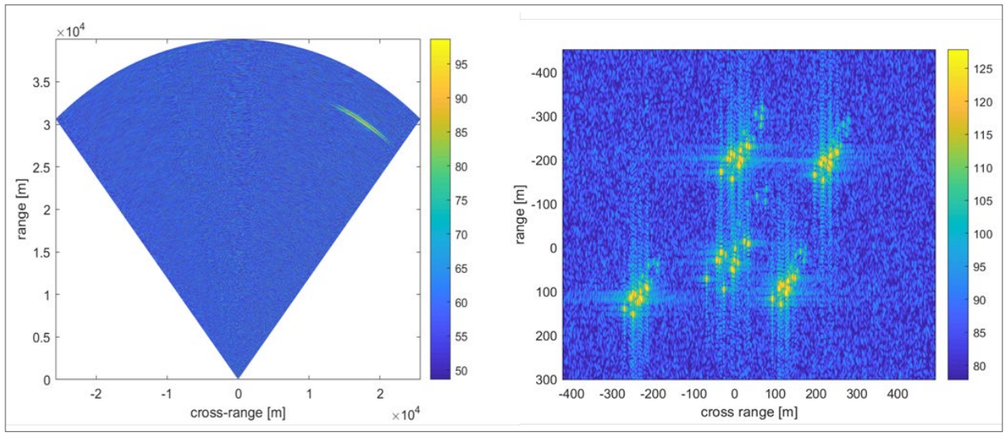
(b) DBF architecture



(c) AESA antenna of 96 patches grouped into 24 QTRM modules of 4 patches each



(d) Output of the MUSIC algorithm in the case of the presence of a target and a jammer source with variable DoA



(e) Preliminary results on the radar imaging technique application.

PROJECT SEPROM

Smart Electronic PROtection Me

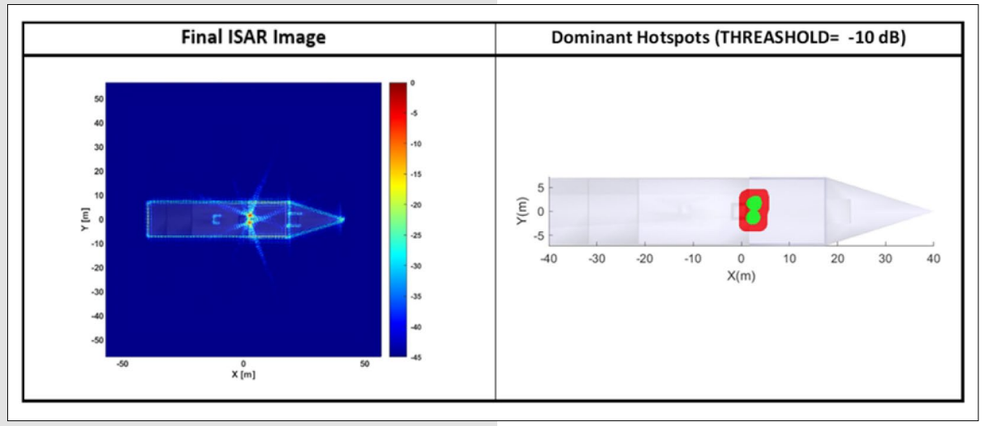
The project purpose is to analyze the possibility of developing a new generation of intelligent electronic warfare means for platform self-protection and to study the development and testing of components necessary for electronic warfare (EW) platform protection. In particular, the goal of the consortium members is to develop and analyze the possibilities of deploying future solutions of intelligent electronic protection measures on the modern (future-oriented) electronic warfare. The work includes analyses, design, and experiments. The demonstrators are expected to be developed and used in field trials to demonstrate technology/ technological capabilities, readiness and advancement.
CNIT contribution:

- The survivability of a complex platform in an operational environment increases with the reduction of its radar cross section. A platform with a smart 'skin' or coating, able to instantaneously modify the RCS, would be a very clever solution especially in conjunction with other EW protection systems for example chaffs or active chaffs, deployed at the same time.
- The main hotspots contributing to the RCS value can be treated separately, in order to obtain the variation of the RCS. An important issue to be deeply analysed is the arrival direction of the menace. Indeed, in such directions a subset of hotspots can be identified that contribute to RCS value, therefore mainly treating the necessary parts, with a clear advantage in terms of complexity reduction and higher technical feasibility.
- The use of active and passive metasurfaces have been proposed to improve the defense of a naval unit.
- Various solutions have been studied and designed for the construction of passive and active metasurfaces.
- The dynamic RCS measurement system was defined in the basic logic blocks and the related technical specifications have been defined.

After its completion, the measurement system was tested at the Navy facilities in Livorno.

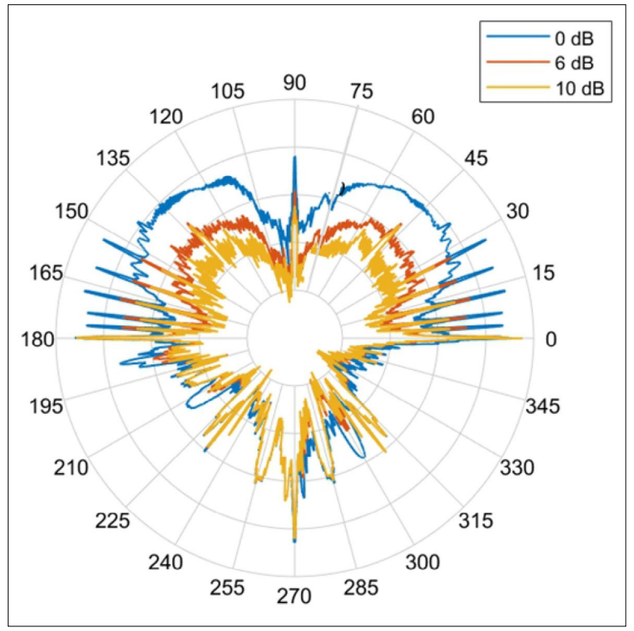
Keywords: Seeker, Digital Beamforming, Jammer, Monopulse, AESA

Technical Sheet
Funding institution:
EDA
Project partners
Warsaw University of Technology, Fraunhofer Institute for High Frequency Physics and Radar Technique, Leading Innovation and Knowledge for Society (LINKS Foundation), EM Techn. Company FreeSpace S.r.l.
Project duration
April 2021 - October 2024
Involved countries
Italy, Germany, Poland

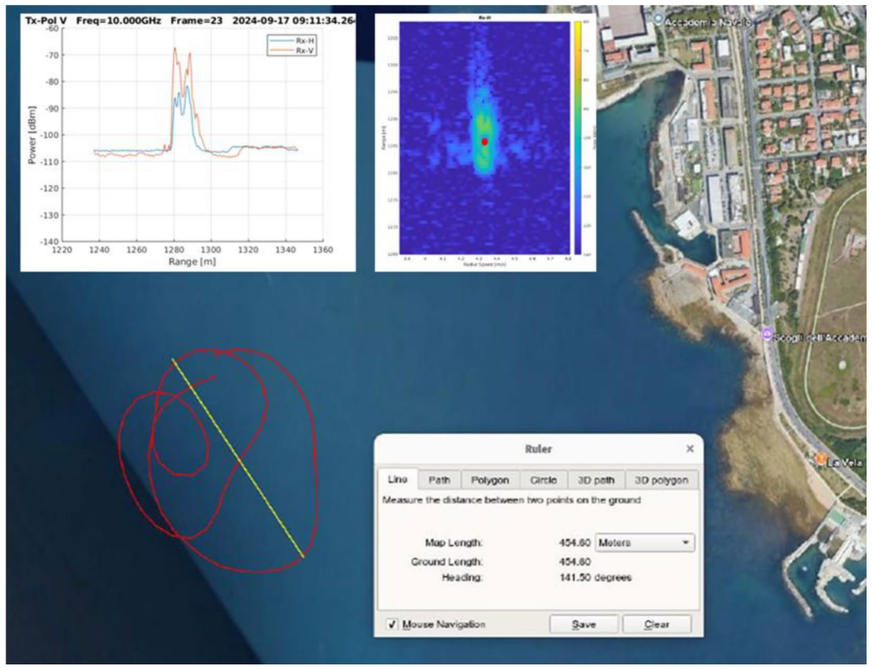


(a) Dominant hotspot localization of a naval model

(b) Measurement of the reflection coefficient of a passive metasurface panel



(c) Simulated RCS reduction of a naval unit in the azimuthal plane due to the use of a metasurface applied on the main hotspots of the target. The legend reads 0 dB for no attenuation and 6 or 10 dB of attenuation when the metasurface is applied.



(d) Measurement campaign at the port of Livorno: range profile and range-Doppler images.

PROJECT SMARTAESA

Scalable & Multifunction SW defined RADAR and fuTure AESA

The objectives of this project are:

1. Study and design of a full digital beamforming radar architecture for open and SW defined multifunction radars. As a case in point, for design purposes only, a radar type MAESA-L, therefore in L band (1 GHz - 2 GHz) and with about a thousand transceiver channels will be considered.
2. The realization of an L-band demonstrator, scaled and of suitable geometry, which uses the full digital beamforming techniques and with the aim of carrying out surveillance activities of appropriate scenarios of interest.

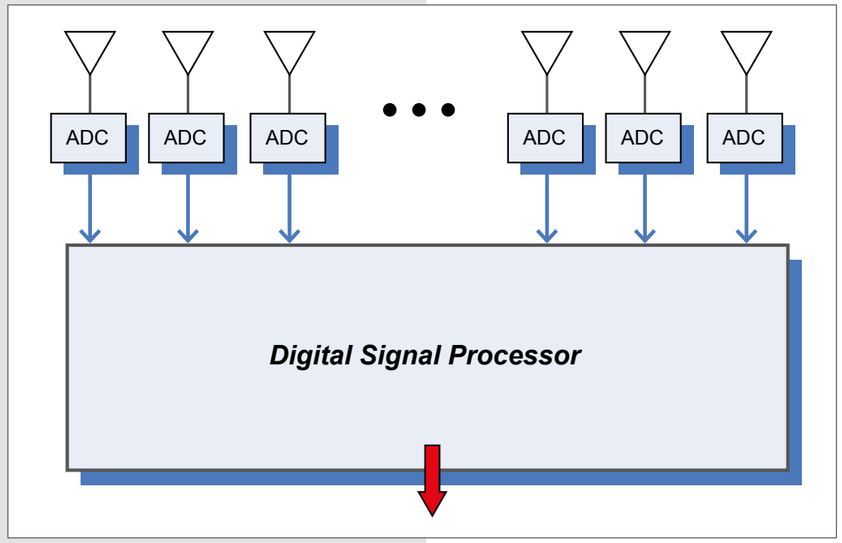
The proposed architecture will have characteristics of scalability, flexibility and adaptability that will allow future multifunction radar systems that will be based on it to:

- Avoid becoming rapidly obsolete with respect to the evolution of the threats they must counter.
- Be easily improved / upgradeable by means of firmware / software upgrades (e.g. implementation of accessory functions and / or the implementation of advanced signal processing based on Artificial Intelligence algorithms).

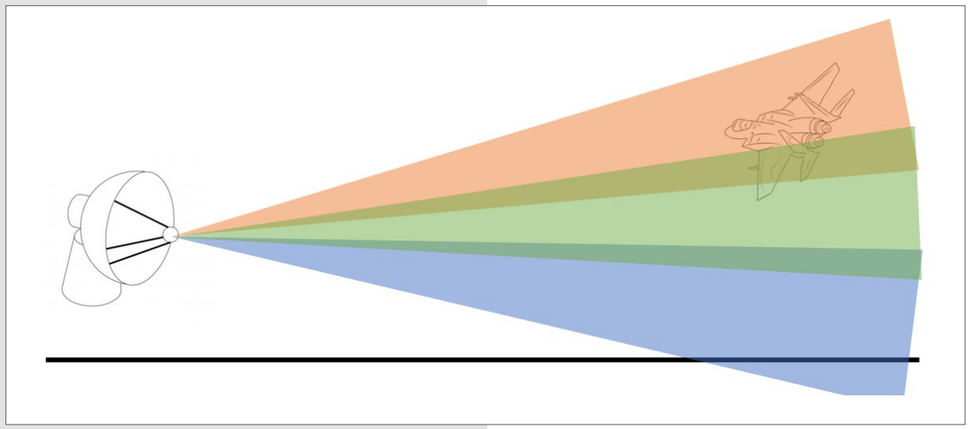
RaSS activities include the study of cognitive radar techniques and their advantages with respect to conventional techniques in terms of clutter cancellation and the development of monopulse method for the DoA estimation.

Keywords: AESA, DBF, DAR, Cognitive, DoA

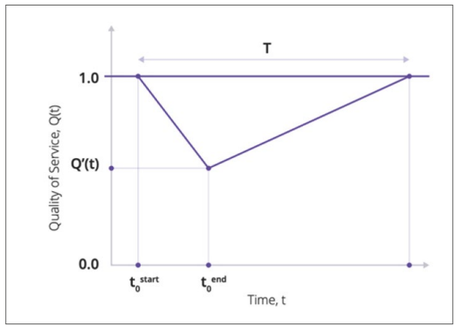
Technical Sheet
Funding institution:
Italian MoD
Project partners
Leonardo spa, Echoes srl
Project duration
April 2020 - April 2023
Involved countries
Italy



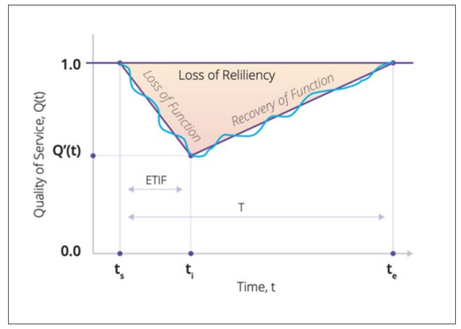
(a) Digital Array Radar Architecture



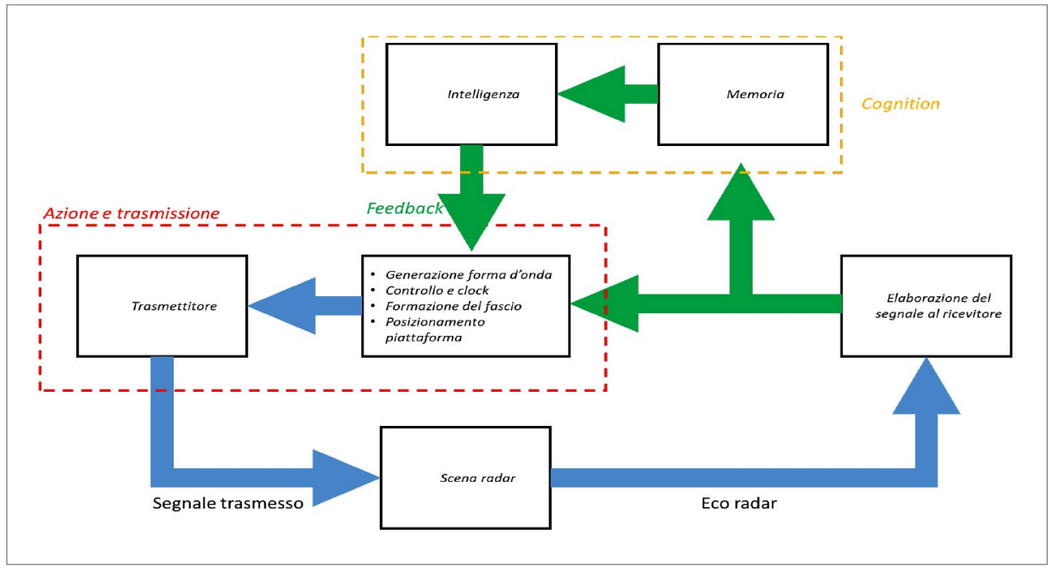
(b) Simulated multiple fan-beam geometries



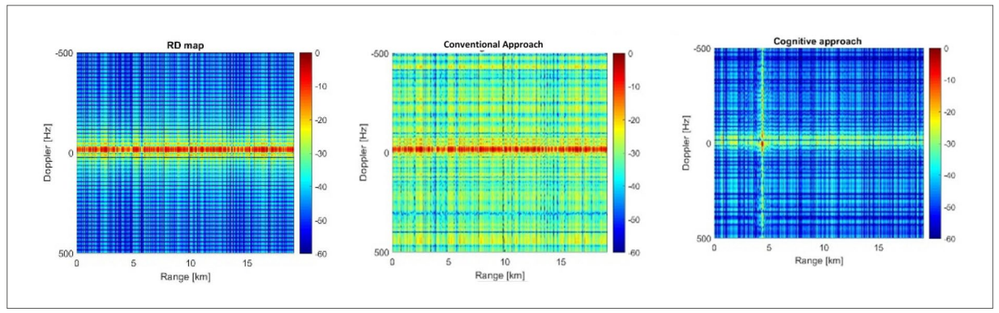
(c) Zobel model of cyber resilience



(d) Reference model of cyber resilience



(e) High level block diagram of cognitive processing for clutter cancellation



(f) Results of cognitive clutter cancellation vs conventional techniques.

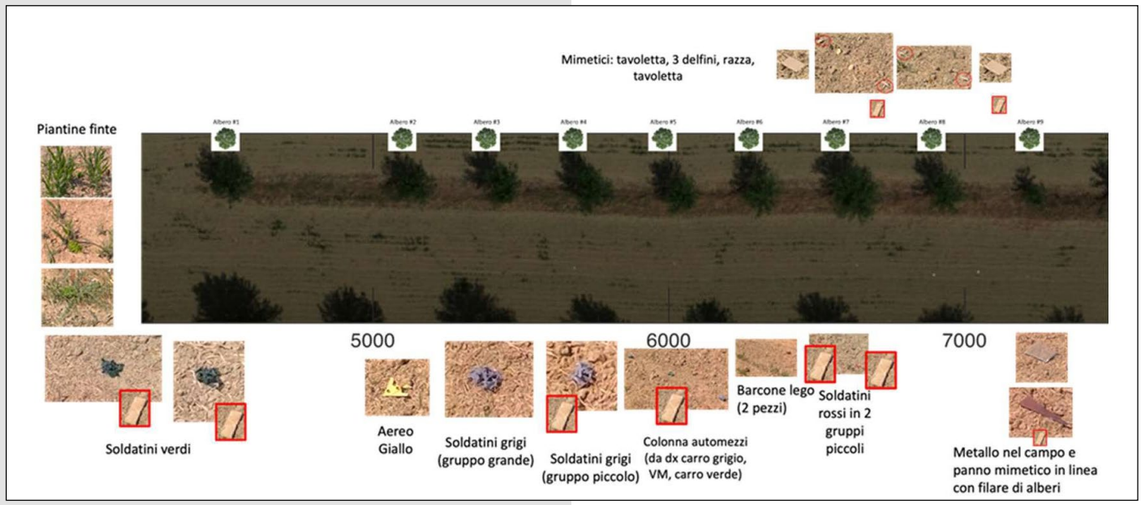
PROJECT SR4IS

Super Risoluzione spaziale per immagini Iperspettrali Satellitari-FASE II

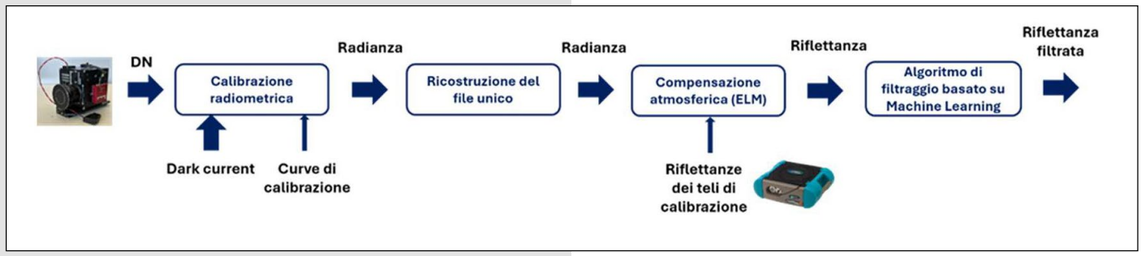
A critical element of satellite hyperspectral (HS) technology (HS-SAT) is the limitation on spatial resolution. The SR4IS project defines processing strategies capable of extracting spectral information at a lower spatial scale by analyzing the hyperspectral image itself and/or jointly analyzing data acquired with other sensors (broadband or multispectral) characterized by higher spatial resolution.
Specifically, the SR4IS project refers to the hyperspectral sensor of Italian Space Agency's (ASI) Earth observation mission named PRISMA (Hyperspectral Precursor of the Application Mission).
In Phase I two distinct approaches were identified to extract details at a better spatial resolution than that of an HS-SAT sensor. The first approach is based on the fusion of a low spatial resolution hyperspectral image (HS-LR) with a high spatial resolution multispectral image (MS-HR). This approach is known in the literature as hyperspectral super-resolution (HS-SR) or HS-MS fusion. The second approach, mainly related to the search for a specific object/material of interest, involves applying detection techniques capable of identifying a specific material occupying a small portion of the pixel under test. This approach leads to the definition of techniques called Sub-Pixel Detection (SPD).
The objective of Phase II is to test the methodologies developed in Phase I on real data. Specifically, for the HS-MS fusion technique, the aim is to apply it to real PRISMA and Sentinel 2 image pairs concerning the same scenario and with close acquisition times. For the SPD methodology, the aim is to apply it to real PRISMA images. Additionally, to verify its potential in a completely controlled environment, the methodology is applied to images acquired using a hyperspectral sensor mounted on a drone available to the project team. To this end, an ad hoc measurement campaign is conducted to exemplify significant scenarios for SPD applications.

Keywords: Super resolution, hyperspectral satellite images, Sub-pixel target detection

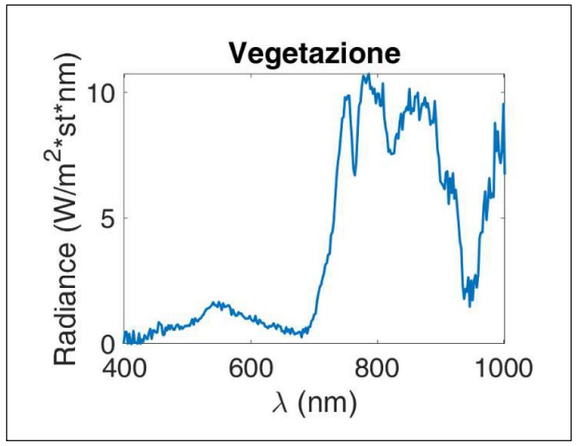
Technical Sheet
Funding institution:
Italian MoD
Project partners
University of Pisa, National Research Council
Project duration
June 2024 - June 2025
Involved countries
Italy



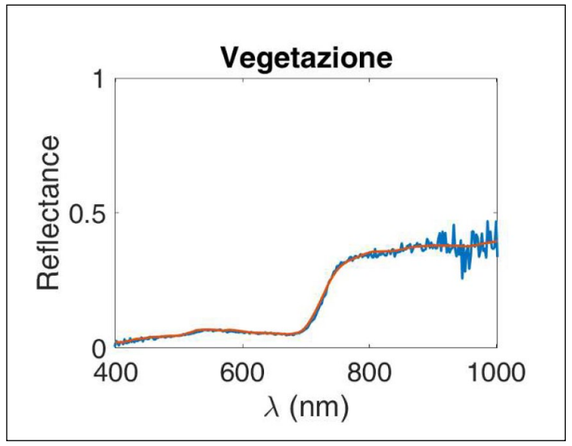
(a) Drone based experimental campaign: measurement field and targets deployed



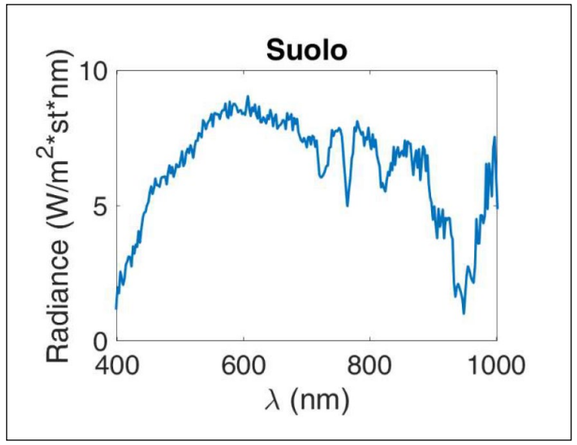
(b) Processing chain for hyperspectral data acquired during the measurement campaign



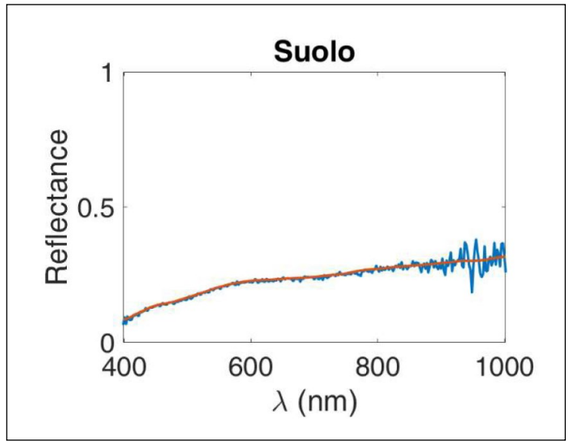
(c) Example of spectral data of vegetation acquired during the campaign: spectral radiance



(d) Example of spectral data of vegetation acquired during the campaign: spectral reflectance before (blue) and after (red) filtering



(e) Example of spectral data of soil acquired during the campaign: spectral radiance



(f) Example of spectral data of soil acquired during the campaign: spectral reflectance before (blue) and after (red) filtering.

PROJECT TAN TOM

Tanning Tomography

The TAN-TOM project, funded under the Fund for Sustainable Growth of the Ministry of Enterprise and Made in Italy (MISE), focuses on non-invasive analysis techniques for leather processed in the tanning sector. It employs new multispectral optical and electromagnetic tomographic acquisition systems, utilizing artificial intelligence-based processing.
The project involves five partners, including three key companies operating in diverse industrial sectors:

- Barnini srl: Lead Company, specialized in automated systems
- SIRIO Lavorazione Conciaria srl: Expertise in tanning processes for third parties.
- TECNOCREO Engineering: Operates across various national industrial sectors.

Additionally, two Research Organizations contribute:

- National Inter-university Consortium for Telecommunications (CNIT): An ICT-focused non-profit research body.
- Experimental Station for the Leather and Tanning Materials Industry srl (SSIP): A National Research Body for the leather supply chain, serving as the Scientific Coordinator of the Project.

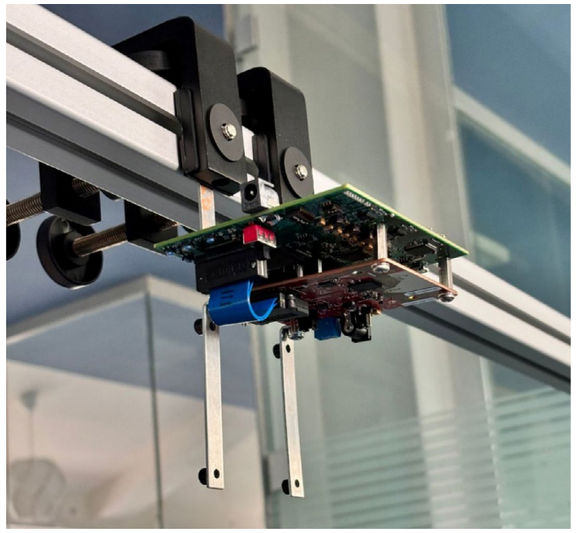
Furthermore, four high-profile companies contribute as consultants:

- COMPOLAB: An engineering firm skilled in multidisciplinary development of advanced solutions, from ideation to industrialization.
- FREE SPACE: An innovative startup dedicated to researching, designing, and producing systems and devices for electromagnetic signal generation, control, and transfer.
- BCN: A tanning company with over 80 years of experience, specializing in managingìcomplex R&D projects, combining craftsmanship, technological innovation, and eco-sustainability in its third generation.
- FLYSIGHT: An SME operating in the defense, aerospace, and infrastructure sectors, producing decision-support software solutions based on artificial intelligence and augmented reality.

The project aims to create a “tomographic” leather inspection system (TAN-TOM) with high strategic potential for the development of the leather supply chain. This system will enable the analysis of leather quality during manufacturing processes, ensuring continuous monitoring and the development of advanced technological diagnostic systems for quality assurance. Within the project, RaSS studied the interaction of the electromagnetic waves with the leather and then identified a radar system to perform experiments with leather samples.
The experiments demonstrated the ability of the radar to detect metallic objects concealed within or behind the leather sample.

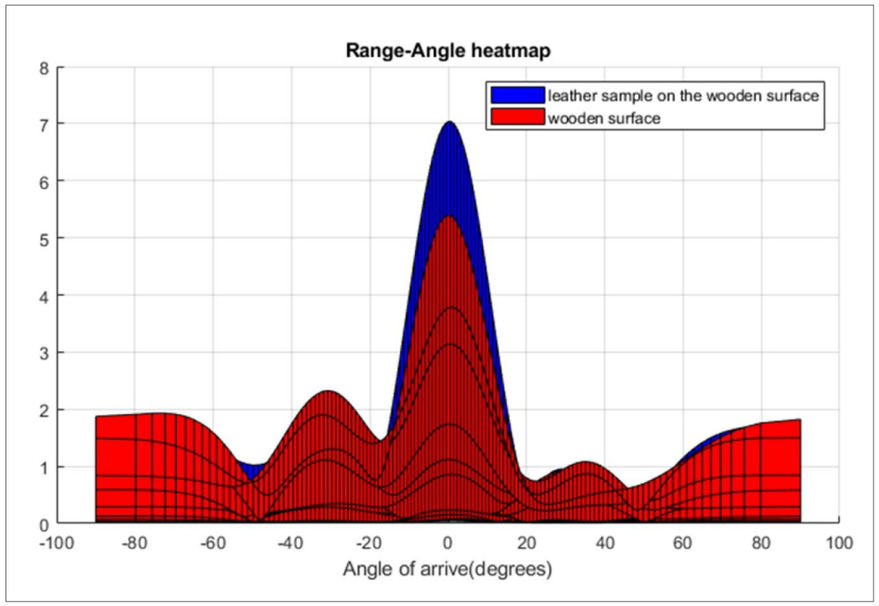
Keywords: Leather analysis, FMCW radar, AI, tomographic analysis

Technical Sheet
Funding institution:
Ministero delle Imprese e del Made in Italy (MISE)
Project partners
Barnini srl, TECNOCREO srl., S.I.R.I.O S.r.l., Stazione Sperimentale per l’Industria delle Pelli e delle materie concianti (SSIP)
Project duration
April 2023 - April 2026
Involved countries
Italy

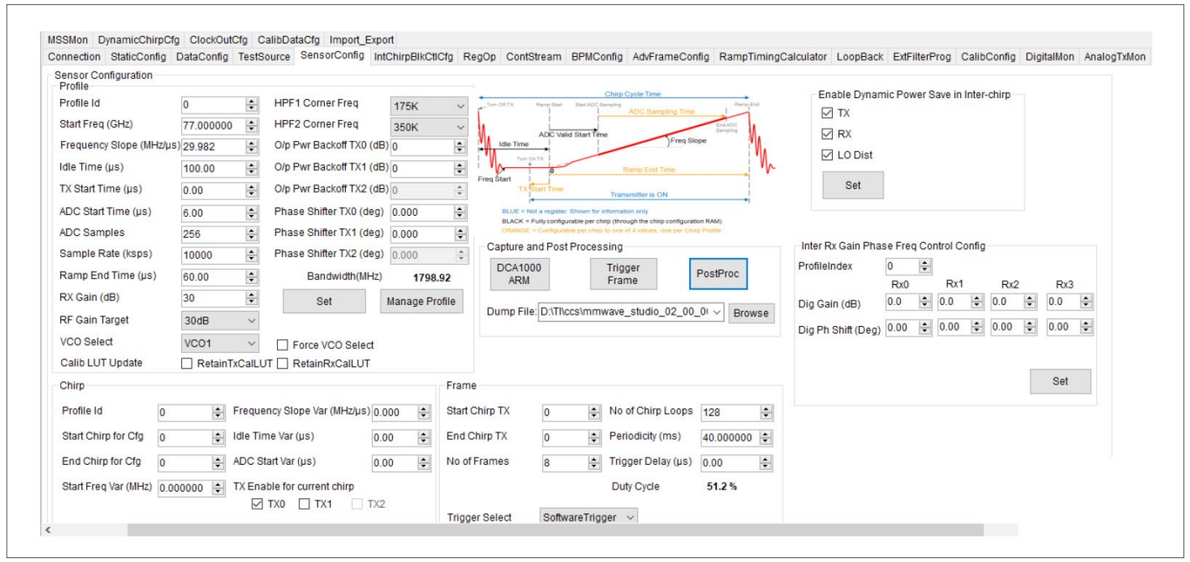


(a) Close-up view of the EHF radar (78 GHz) experimental setup: the red board is a TI AWR1642 mmWave FMCW automotive radar - the green board is a TI DCA1000 raw data capture card

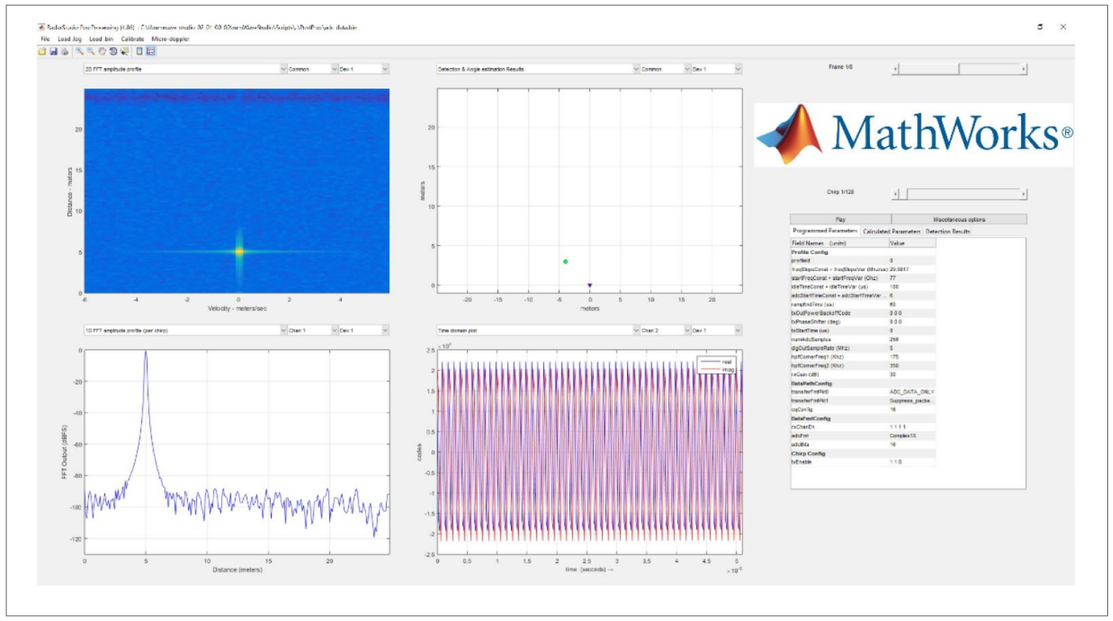
(b) Set of defected leather sa



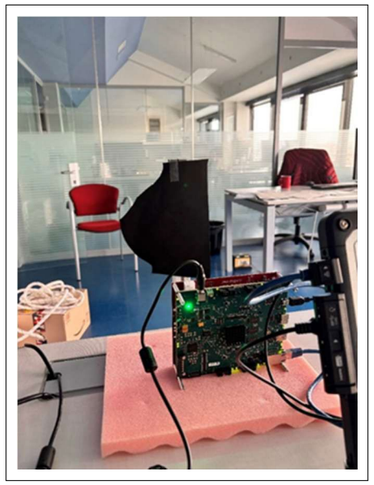
(c) EHF radar (78 GHz) first experimental results on a leather sample: range-angle heatmap with and without the supporting surface



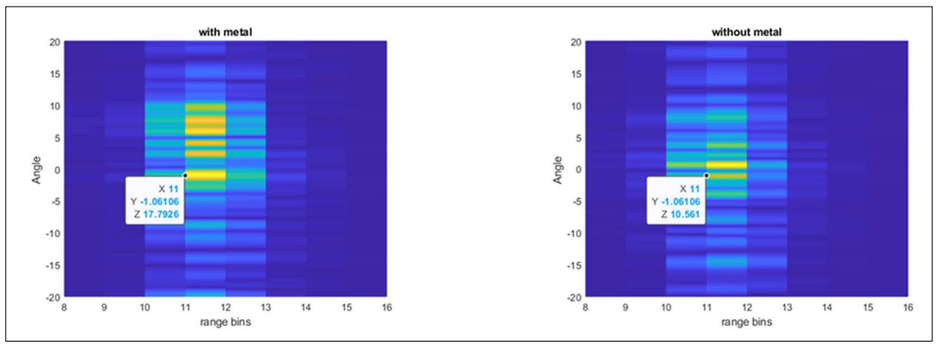
(d) Software support implementation: Texas Instrument mmWave Studio software (MMWAVE-STUDIO: https://www.ti.com/tool/MMWAVE-STUDIO)



(e) Software support implementation: MATLAB Runtime Eng (MATLAB Runtime Engine: https://www.mathworks.com/)



(f) MMWCAS-RF-EVM radar system - lab setup



(g) Range Doppler map (after range and Doppler gating) of the leather sample (on the left).
On the right, the Range Doppler map of the leather sample with a metallic object hidden behind the sample itself.

PROJECT TIRESYAS

Technology Innovation for Radar European SYstem ApplicationS

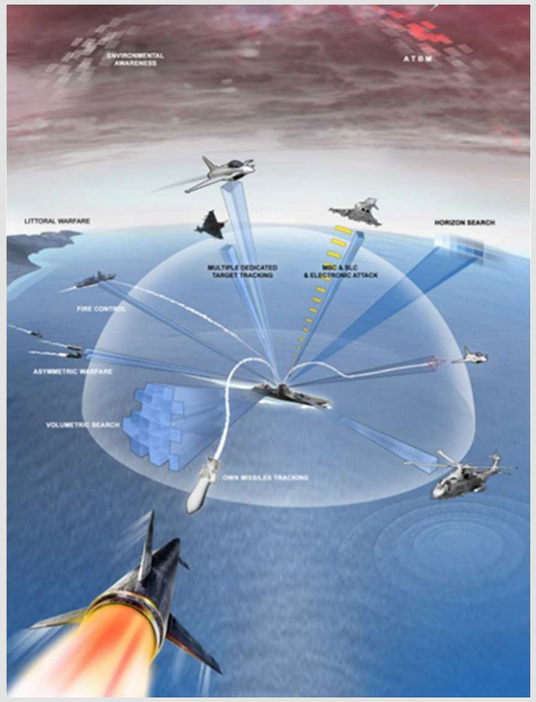
The project TIRESYAS aims at countering emerging threats with increasing sensor resilience. Boosting the cooperation launched under the EDF ARTURO project (Advanced Radar Technologies in eUROpe, funded under EDF2021), TIRESYAS will pursue new research activities including new approaches to radar surveillance and target tracking through innovative algorithms able to combine different radar architectures and will further advance towards a fully digital and disruptive multi-function/multidomain/multi-platform radar system.
The TIRESYAS project will be focusing on:

1 Dual-band / multi-band and multi-functional aperture Radar operating with different radar frequencies.

2 Multi-domain high-end sensors mainly devoted to the defence against new generation of innovative threats such as hypersonic missiles.

The TIRESYAS consortium consists of partners from 11 Countries, covering the whole value chain from applied research to high technology product development and supply. The analysis and development of innovative concepts and technologies in the framework of the TIRESYAS project will generate a technological advantage for EU by recovering existing gaps and figuring out the most comprehensive and disruptive design for the next generation European radar capability at system and sub-system level. At operational level, TIRESYAS will realize a project for a new class of multidomain radar. The TIRESYAS project aims to offer solutions in different environments and scenarios and make them interoperable with existing air defence and force protection systems, employing various degrees of interconnection and integration according to the scenario, environment, and type of protection.

Keywords: AESA, Polarimetric Radar, Hypersonic target detection, Cognitive Radar, AI, Digital array processing, Cybersecure radars



(a) Dual Band / Multi Band Radar concept (image courtesy of Leonardo).

Technical Sheet

Funding institution:

EU EDF

Project partners

Leonardo S.p.A. (LDO, Coordinator) Italy, AALTO KORKEAKOULUSAATIO (AALTO) Finland, AIRBUS DEFENCE AND SPACE GMBH (AIR) Germany, BALTIJOS PAZANGIU TECHNOLOGIJU INSTITUTAS (BPTI) Lithuania, CONSORZIO NAZIONALE INTERUNIVERSITARIO PER LE TELECOMUNICAZIONI (CNIT) Italy, CoreHW Semiconductor Oy (CHV) Finland, ECHOES SRL (ECH) Italy, ELETTRONICA (ELT) S.p.A. Italy, FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV (FHR) Germany, HENSOLDT SENSORS GMBH (HEN) Germany, INDRA SISTEMAS SA (INDRA) Spain, MARDUK TECHNOLOGIES OU (MAR) Estonia, MBDA ITALIA SPA (MBDA) Italy, NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK (TNO) Netherlands, PIT RADWAR SA (PIT) Poland, Rheinmetall Italia S.p.A.(RHI) Italy, SAAB AKTIEBOLAG (SAAB) Sweden, SAS UPMEM (UPMEM) France, SATWAYS-OLOKLIROMENES LYSEIS ASFALEIAS KAI AMYNASIDIOTIKI EPICHEIRISI PAROCHIS YPIRESION ASFALEIAS (IEPYA)-ETAIREIA PERIORISMENIS EFTHYNIS (STWS) Greece, SenTech Srl (Sentech) Italy, THALES DMS FRANCE SAS (THA) France, THALES NEDERLAND BV (TNL) Netherlands, TOTALFORSVARETS FORSKNINGSINSTITUT (FOI) Sweden, UNIVERSITAT POLITECNICA DE VALENCIA (UPV) Spain, XY-Sensing sp. z o. o. (XY-Sensing) Poland

Project duration

September 2024 - August 2027

Involved countries

Italy, France, Spain, Germany, Sweden, Finland, Netherlands, Poland, Lithuania, Estonia, Greece

PROJECT WATCHEDGE

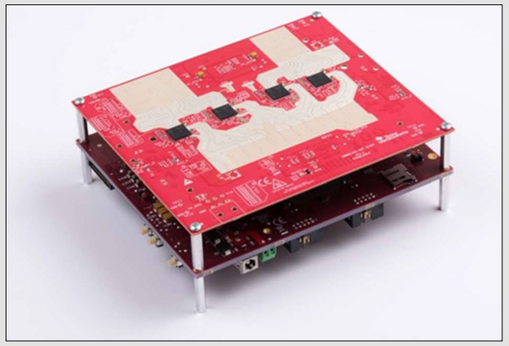
Wide-area Agile and flying neTwork arCHitecture for AI-surveillance processing at the EDGE - RESTART

The WatchEDGE project aims to establish a geographically distributed infrastructure to enhance surveillance in rural environments, addressing threats such as wild animals, wildfires, and invasive species. Recognizing that rural areas often comprise fragmented properties owned by different stakeholders, WatchEDGE proposes a shared monitoring system that benefits the entire community. Individual efforts, while effective locally, fail to account for regional scale threats, such as roaming wildlife crossing property boundaries.
The project envisions leveraging existing technological resources (e.g. trail cameras, UAV-mounted cameras, radar, local networks, and servers) already available to individual property owners.
By integrating these into a unified system, WatchEDGE aims to deliver advanced monitoring capabilities at a sustainable cost. Central to the initiative is the application of Artificial Intelligence (AI) and Vision Computing (VC) for real-time identification and classification, providing essential situational awareness.
The activities carried out by RaSS Laboratory regarding this project over this year focused on analyzing clutter cancellation techniques in outdoor environments to enhance the detection performance of wild animals. In this context, the TI MMWCAS-DSP-EVM radar was used as a reference, and a preliminary measurement campaign was conducted at Parco San Rossore in Pisa.

Keywords: Digital array processing, Radar for agriculture, Animal Detection, Wild-Area Surveillance.

RESTART
WatchEDGE
Funded by the European Union NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani

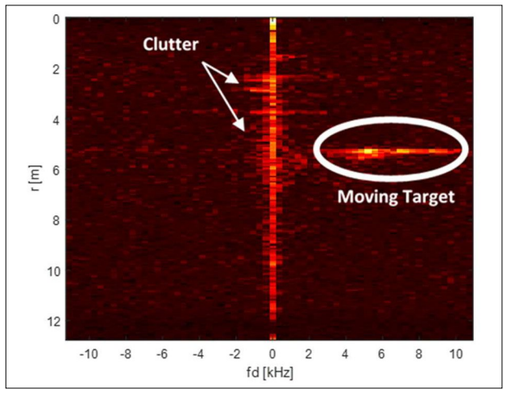
Technical Sheet
Funding institution:
European Union under the Italian National Recovery and Resilience Plan (NRRP) of NextGenerationEU
Project partners
POLIMI, UNICT, Italtel, UNIPI, Università di Milano Bicocca, Nextworks, Sensor-ID
Project duration
January 2023 - January 2026
Involved countries
Italy



(a) TI MMWCAS-DSP-EVM Evaluation Board used during the measurement campaign

(b) Instruments set-up in Parco San Rossore

(c) Measurements validation in Parco San Rossore



(d) Range-Doppler map of a moving human target within clutter during the measurement campaign.

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CERTIFICATIONS

Since January 2017 the RaSS Lab has been certified ISO 9001/2015 by the international and independent body DNV GL. The certification refers to the "Design and development of technology systems and services in telecommunications, radar and electromagnetism and related computer aids and the design and manufacture of RF and microwave equipment and subsystems" (Figure 4).

DNV

MANAGEMENT SYSTEM CERTIFICATE

Certificate no.:
211274-2016-AQ-ITA-ACCREDIA

Initial certification date:
19 January 2017

Valid:
20 January 2023 – 19 January 2026

This is to certify that the management system of

Consorzio Nazionale Interuniversitario per le Telecomunicazioni - Laboratorio Nazionale RaSS - Radar e Sistemi di Sorveglianza
Galleria G.B. Gerace, 18 Sesto Piano - 56124 Pisa (PI) - Italy

has been found to conform to the Quality Management System standard:
ISO 9001:2015

This certificate is valid for the following scope:
Design and development of technology systems and services in telecommunications, radar and electromagnetics and related computer aids. Design and manufacturing of radiofrequency and microwaves equipments and subsystems (IAF 34, 19, 33)

Place and date:
Vimercate (MB), 09 December 2022

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SGA N° 003 D
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SSI N° 002 G

Membro di MLA EA per gli schemi di accreditamento SGQ, SGA, PRD, PRS, ISP, GHG, LAB e LAT, di MLA IAF per gli schemi di accreditamento SGQ, SGA, SSI, FSM e PRD e di MRA ILAC per gli schemi di accreditamento LAB, MED, LAT e ISP

For the issuing office:
DNV - Business Assurance
Via Energy Park, 14, - 20871 Vimercate (MB) - Italy

Claudia Baroncini
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
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Figure 4 – Lab RaSS ISO 9001/2015 DNV certificate.

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- INAF (Istituto Nazionale di Astrofisica), Italy
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- Leonardo, Italy
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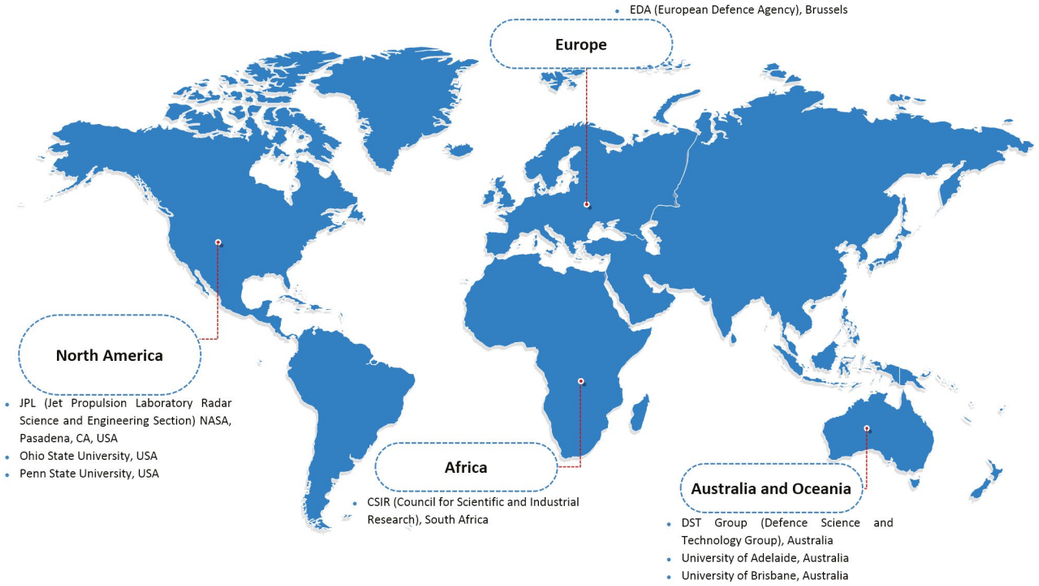

North America

- JPL (Jet Propulsion Laboratory Radar Science and Engineering Section) NASA, Pasadena, CA, USA
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- Penn State University, USA

Africa

- CSIR (Council for Scientific and Industrial Research), South Africa

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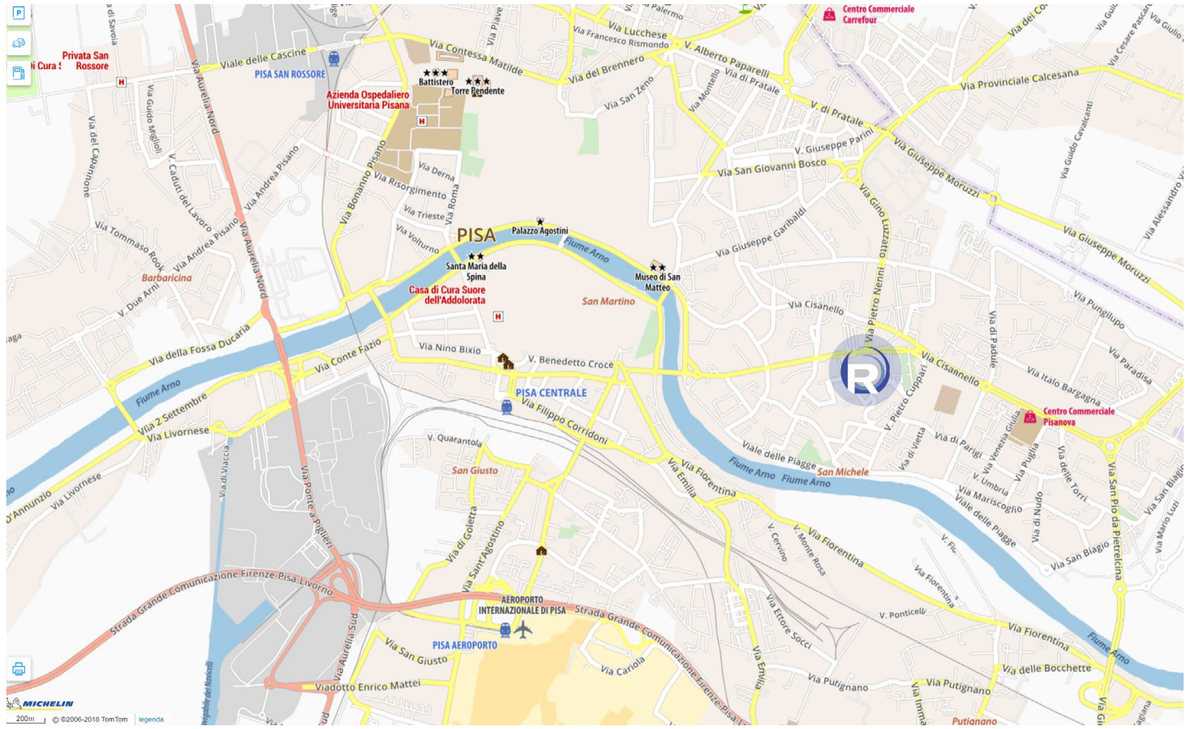

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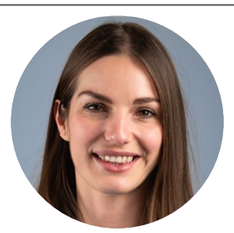

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