2020

Annual report

consorzio nazionale
interuniversitario
per le telecomunicazioni

National Lab RaSS
Radar and Surveillance Systems

Director’s Introduction

This is our official edition of the Radar and Surveillance Systems (RaSS) Laboratory’s annual report, namely the *2020 RaSS Annual Report*.

This annual report has been prepared with the aim of showcasing the research activities that have been conducted and the major results obtained during this financial year.

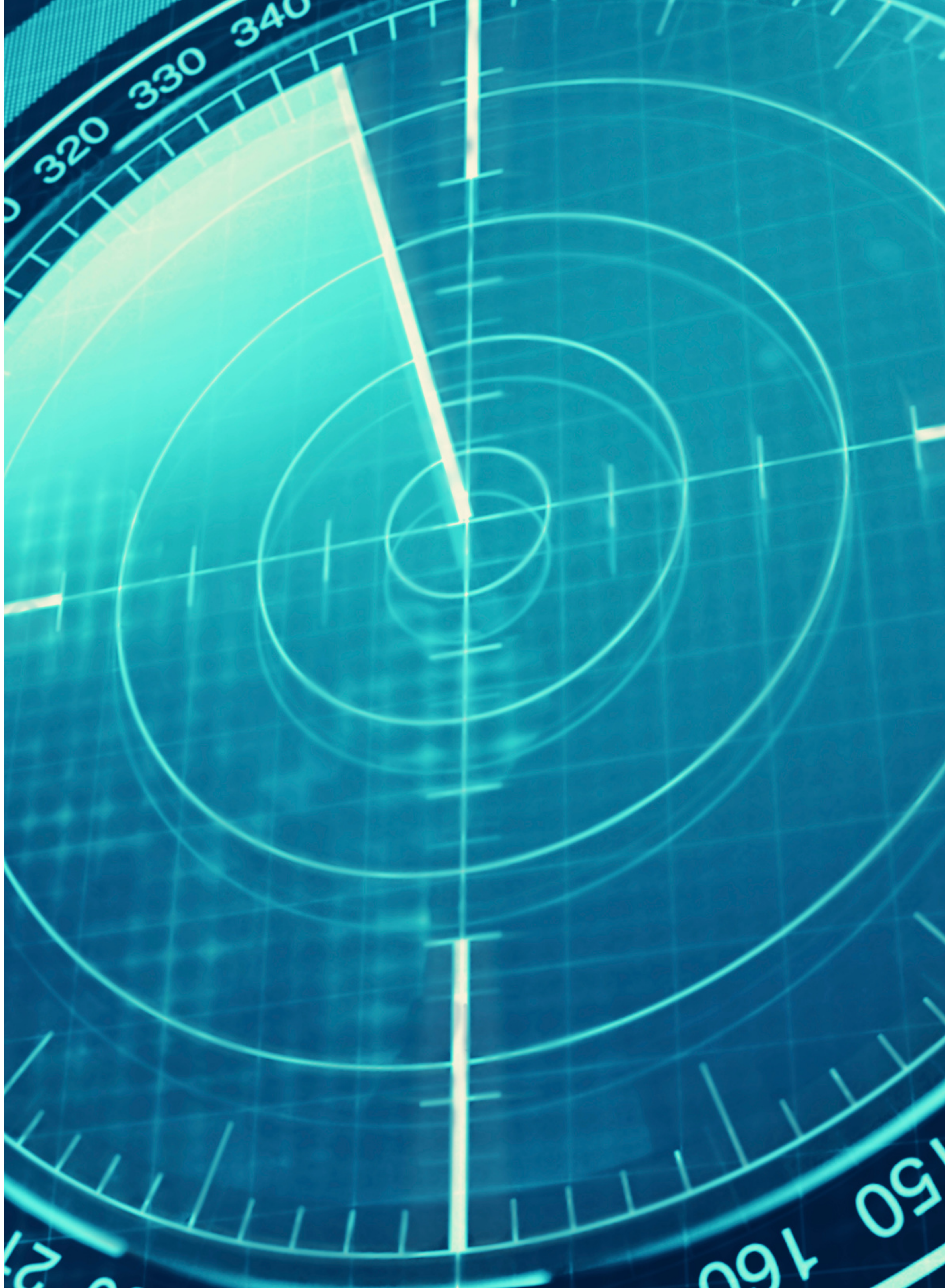
In general, despite the current economical situation due to Covid-19, 2020 has been a very positive year that has seen

- a consolidation of the personnel at RaSS with one new permanent research position
  and two new temporary research positions
- 31 active projects been carried out
- 26 publications published
  29 participating members in 23 conferences, workshops and specialist meetings
- RaSS personnel leading three NATO activities and participating in three additional NATO activities
- four project proposals granted that will see new projects starting at the very beginning of 2021
- RaSS been certified according to ISO 9001/2015 for an additional three-year term (2020-2023)

This report has been kept concise and simple in order to give a brief breath of what RaSS has been concentrating its effort on in the last year. For any additional information, please feel free to contact me at rass@cnit.it.

Sincerely,
Marco Martorella
Director of RaSS

consorzio nazionale
interuniversitario
per le telecomunicazioni



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THE RADAR AND SURVEILLANCE SYSTEMS LABORATORY IN A NUTSHELL

The Radar and Surveillance Systems (RaSS) is a National Laboratory of the National Interuniversity Consortium for Telecommunications (CNIT). CNIT is a no-profit consortium composed of 44 Research Units (37 Italian Universities, 7 Departments of the National Research Council-CNR) and 5 National Laboratories (https://www.cnit.it/en/).
The RaSS Lab was founded in 2010 with the purpose of creating a critical mass to face research challenges in the field of radar and applied electromagnetics. Today, RaSS counts 32 people among researchers, technical and administrative staff.

The RaSS Lab has participated in several national and international research projects (often as leader), funded by the Italian MoD (Ministry of defence), EDA (European Defence Agency), MIUR (Ministry of Education), MISE (Ministry of Economic Development), EU FP7, EU H2020, ESA (European Space Agency), EOARD (European Office of Aerospace Research and Development), NATO SPS (Science for Peace and Security), NCIA (NATO Communications and Intelligence Agency), ARMASUISSE, ASI (Italian Space Agency), Tuscany Region, Industries like LEONARDO, MBDA, VITROCISET, INTERMARINE, GEM, E-GEOS, TELEDYNE, among others.

RaSS strives to maintain, and when possible to increase, the quality and excellence of the research activities and the results achieved. At the same time, it seeks to strengthen and consolidate its structure and to invest in basic research in new promising areas.
RaSS places itself between academia and industry with the aim to fill the gap existing between them. Many research projects that have been carried out at RaSS have led to the development of fully integrated demonstrators with TRLs between 5 and 6.
RaSS also focuses its effort on dissemination activities, including journal and book publications, presentations at international conferences, training activities under the form of short courses, tutorials, seminars and lectures for industry, government and various research institutions.
RaSS values all its collaborations nationally and internationally, counting today more than 50 partners across, industry, academia and both government and non-government research institutions.
RaSS has a strong participation in both NATO and EDA contexts, where its personnel hold key roles within Panels and CapTechs.
RaSS has spun off two companies, namely ECHOES and FREESPACE. The former focuses on the design and development of radar systems whereas the latter deals with the design and production of advanced antenna concepts and electromagnetic compatibility. Both ECHOES AND FREESPACE improve the ability of RaSS to produce effective technological transfer.

FINANCIAL STATS

The RaSS Laboratory budget comes from several sourcing of financing. The following figure outlines the lab's financial trend from FY 2017 through FY 2020.

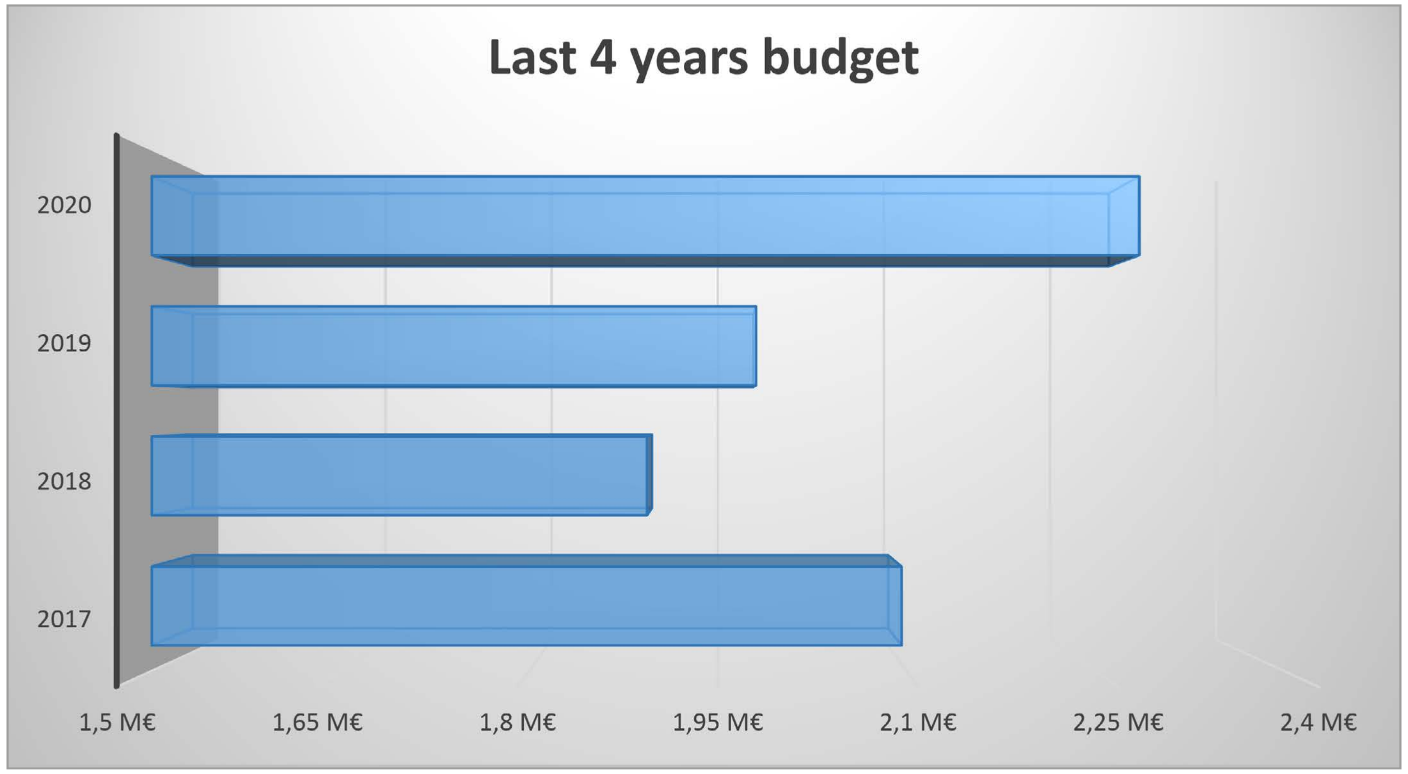


Figure 1 - RaSS Lab financial trend from FY 2017 through FY 2020

ORGANISATION CHART

Figure 2 shows the organisational chart of the RaSS Lab as on 31 December 2020.
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, antenna, electromagnetic modelling & materials. RaSS also has an explorative research area, where promising basic research is internally funded, an instrumental laboratory and a security office to handle classified information.
On the administration side, RaSS is composed of a secretariat office, a quality control office and a public relation office. RaSS governance is directed by the Steering Committee, which is chaired directly by the Director.

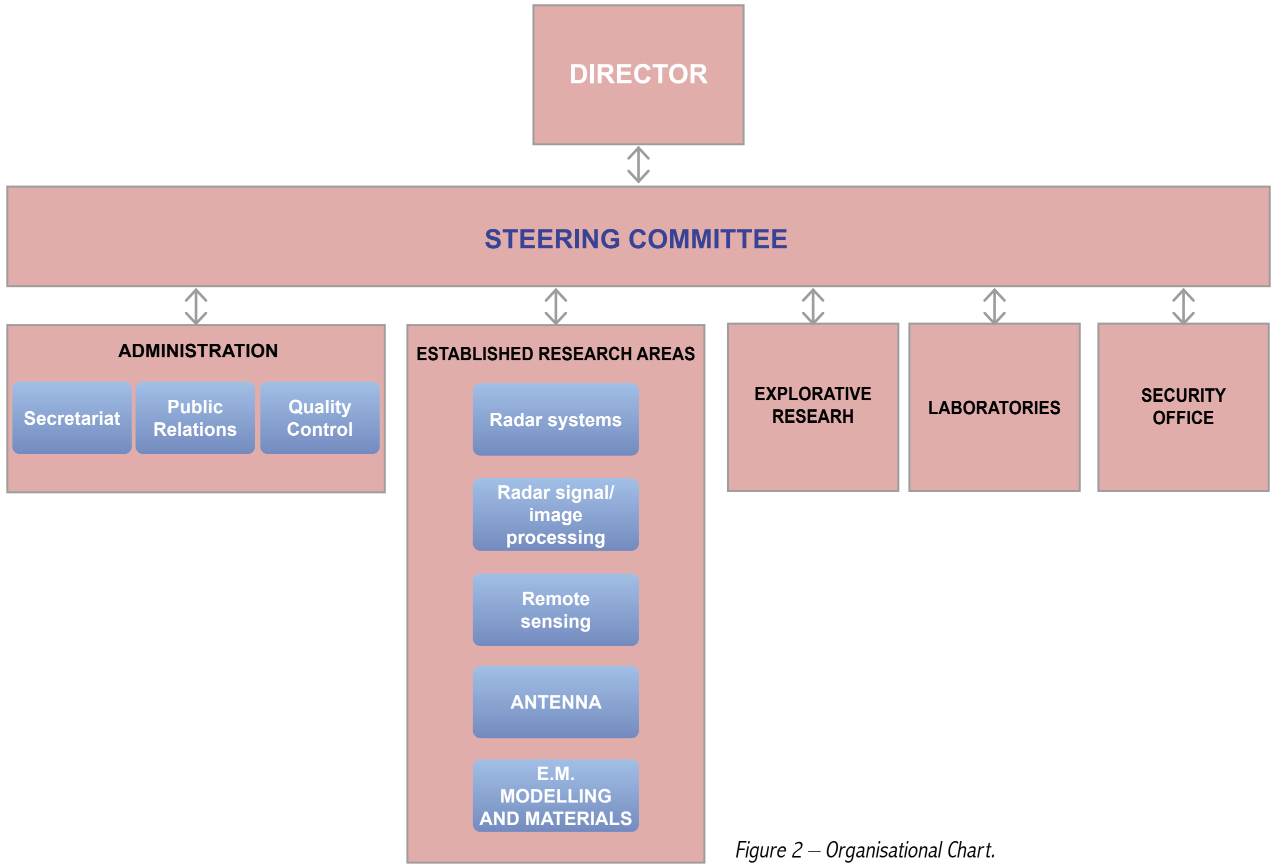


Figure 2 – Organisational Chart.

DIRECTOR

Prof. Marco Martorella received his Laurea degree (Bachelor+Masters) in Telecommunication Engineering in 1999 (cum laude) and his PhD in Remote Sensing in 2003, both at the University of Pisa. He is now an Associate Professor at the Department of Information Engineering of the University of Pisa and an external Professor at the University of Cape Town where he lectures within the Masters in Radar and Electronic Defence. Prof. Martorella is also Director of the CNIT's National Radar and Surveillance Systems Laboratory. He is author of more than 200 international journal and conference papers, 3 books and 17 book chapters. He has presented several tutorials at international radar conferences, has lectured at NATO Lecture Series and organised international journal special issues on radar imaging topics. He is a member of the IEEE AES Radar Systems Panel, a member of the NATO SET Panel, where he sits as co-chair of the Radio Frequency Technology Focus Group, and a member of the EDA Radar Captech. He has chaired several NATO research activities, including three Research Task Groups, one Exploratory Team and two Specialist Meetings. He has been recipient of the 2008 Italy-Australia Award for young researchers, the 2010 Best Reviewer for the IEEE GRSL, the IEEE 2013 Fred Nathanson Memorial Radar Award, the 2016 Outstanding Information Research Foundation Book publication award for the book Radar Imaging for Maritime Observation and the 2017 NATO Set Panel Excellence Award. He is a co-founder of ECHOES, a radar systems-related spin-off company. His research interests are mainly in the field of radar, with specific focus on radar imaging, multichannel radar and space situational awareness. He is a Fellow of the IEEE.

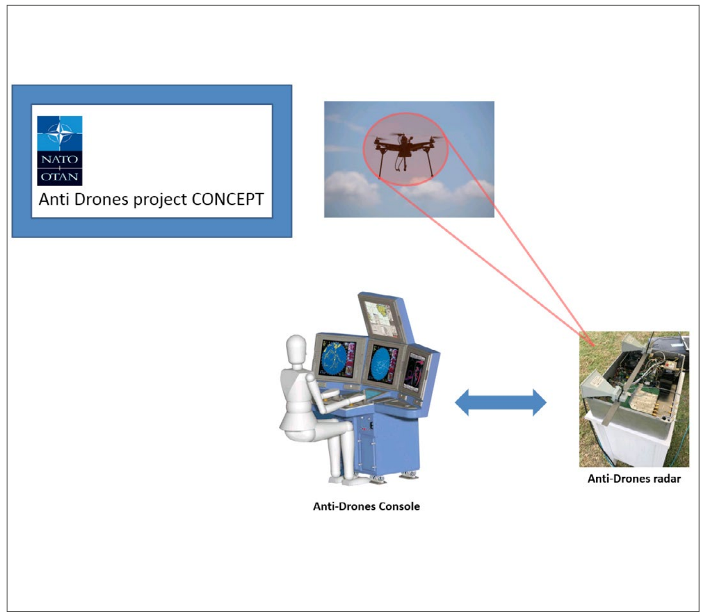
Active Projects

PROJECT ANTI-DRONES

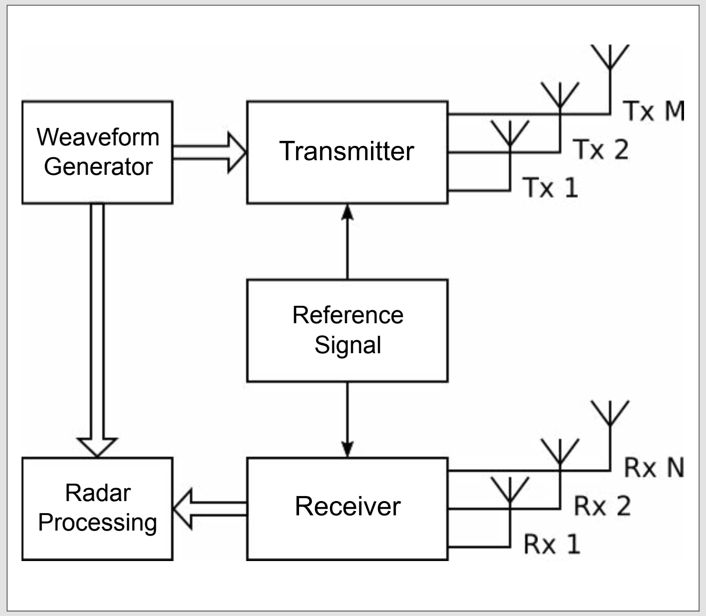
Innovative concept to detect, recognize and track "killer-drones"

The project focuses on the development of a new concept of anti-drone system, which able to detect, recognize and track killer-drones – mini/micro UAVs - in order to facilitate their neutralization and, at the same time, to minimise risks for people and assets.
The realization of Anti-Drones' goal requires the integration of different competences, such as system design and integration, design of antennas and transceiver, development of advanced signal processing algorithms, as well as development of software and firmware. The system is based on the use of software defined technologies and software engineering techniques to guarantee flexibility and re-use of existing technology.
Anti-drones will move forward the current state of the art of anti-drone systems through the use of mini-radar technology and signal processing, which will improve current system performances with minimal environmental impact (e.g. visual impact and EM pollution) to the urban environment.

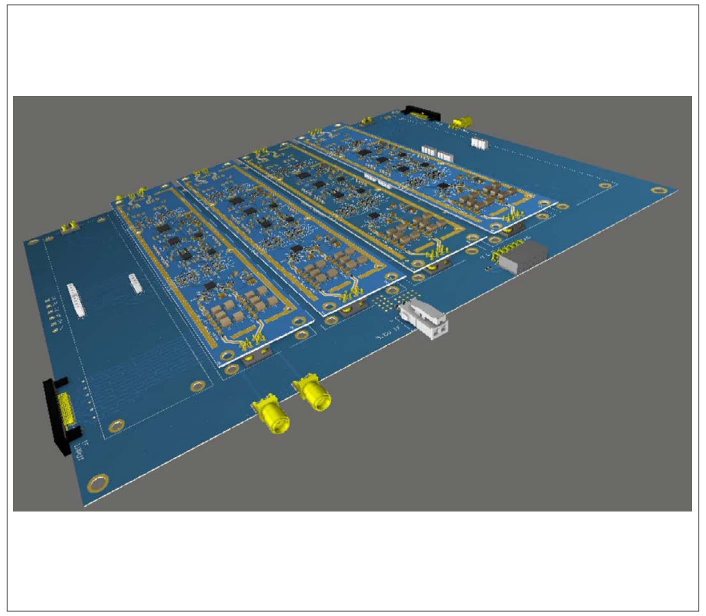
Technical Sheet
Funding institution:
NATO – ESCD – SPS Programme
Project partners
Mother Teresa University (MTU), North Kazakhstan State University (NKSU)
Project duration
September 2019 - March 2022
Involved countries
Italy, North Macedonia, Kazakhstan



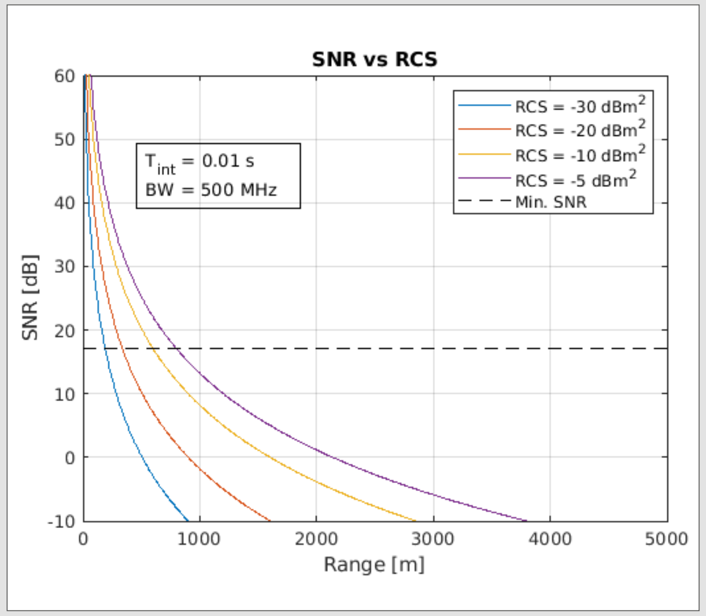
(a) - Anti-Drones project Conceptual Diagram



(b) MIMO Radar schematic



(c) 3D View of the IF board



(d) SNR vs RCS with 15 dBi Antenna gain

PROJECT CAPPA

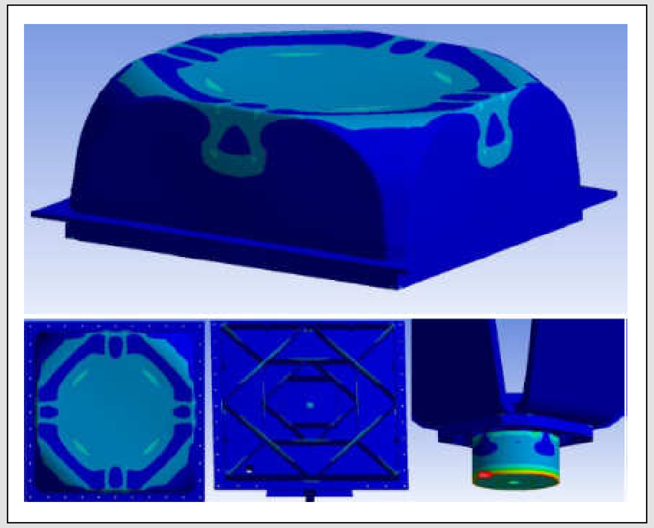
Communication Antennas for PPA

Design, engineering, production and supply of V/UHF communication antennas for Italian Navy Ships PPA (Pattugliatore Polivalente d'Altura), Paolo Thaon Revel Class.
The subsystem is made of two kinds of innovative "conformal" antennas originally developed by CNIT/RASS within the SHIRED project, funded by Italian Ministry of Defence:

- a low-profile omnidirectional monopole mounted on flat metallic surfaces (decks)
- a distributed conformal array flash mounted on deckhouse walls.

The first agreement was about the supply of antenna systems for the first three PPAs, as part of the 2014 Naval Law.
In late 2020 the contract has been renewed for the last four financed vessels.

Technical Sheet
Funding institution:
Leonardo SpA
Project partners
Free Space Srl
Project duration
January 2016 - April 2022
Involved countries
Italy



(a) Antenna Design using electromagnetic and mechanical simulation software;

((b) Antenna Qualification in Open Site at Italian Navy CSSN ITE laboratory;

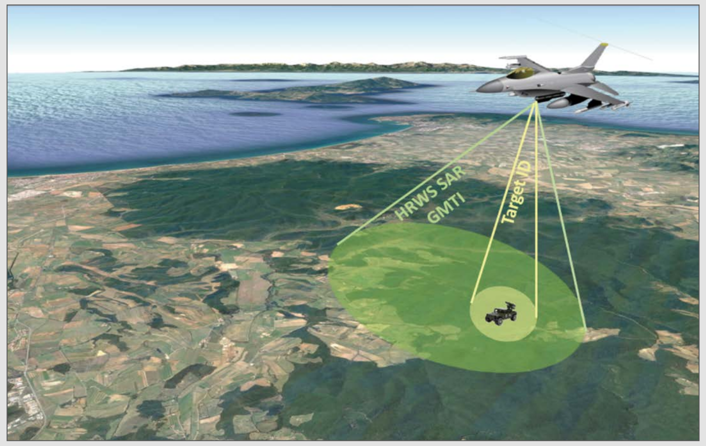
(c) View of the Thaon Revel (PPA1) vessel with CNIT installed antennas during test

PROJECT COGITO

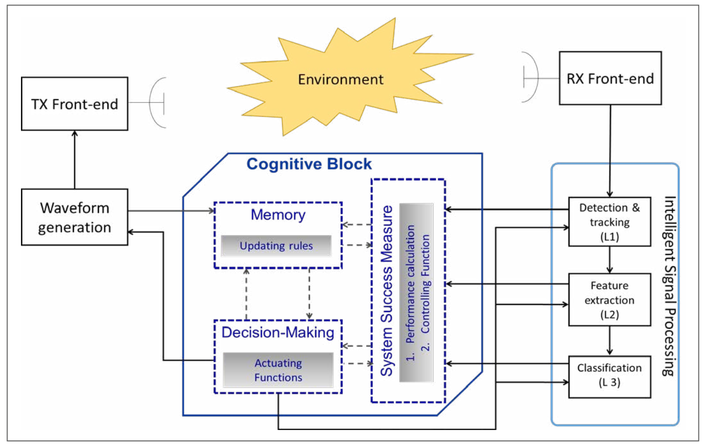
Cognitive radar for enhanced target recognition

The COGITO project represents one of the first attempts to apply a cognitive architecture to the problem of target recognition. Today, in fact, most of the "Cognitive Radar" architectures, either implemented or under study, are focused on the radar capability to automatically select the regions of the frequency spectrum that are free of either intentional or unintentional radio frequency interferences. It should be noticed that such a way of working resembles that of a cognitive radio system more than a cognitive radar system.
The concept of cognitive radar for target recognition is based on the system's ability to understand the environment and to autonomously manage the radar system degrees of freedom (transmitted waveform and received signal processing parameters) as well as the target recognition algorithms.
A cognitive radar that is specifically designed for automatic target recognition will aim at maximizing target recognition performances by exploiting a priori knowledge of the external environment as well as by learning from its successes and failures.
The aim of this project is to develop and test, both on simulated and real radar data, different cognitive radar architectures for automatic target recognition. The project will also provide a performance comparison between classical HRR/ISAR classifiers and the newly developed cognitive architectures. In order of appearance, the images below show an implementation of the COGITO system concept in an operative scenario, the overall system architecture, a more detailed classifier block diagram, where the feedbacks toward the system intelligence are highlighted with different colours, and preliminary results obtained by using a dataset composed of e.m. target models of 4 cars. Results are provided in terms of accuracy, error and precision and are meant to compare the advantage of using cognition when the external environment changes. In the example provided in Fig. 4, the environment changes in terms of SNR. In this case, the system adapts to the environment changes by applying the on-line learning approach proposed in the COGITO project.
Other scenarios have been simulated to prove the classifier capability to drive the transmitter parameters (bandwidth, number of receiving spatial channels and full-pol acquisition).

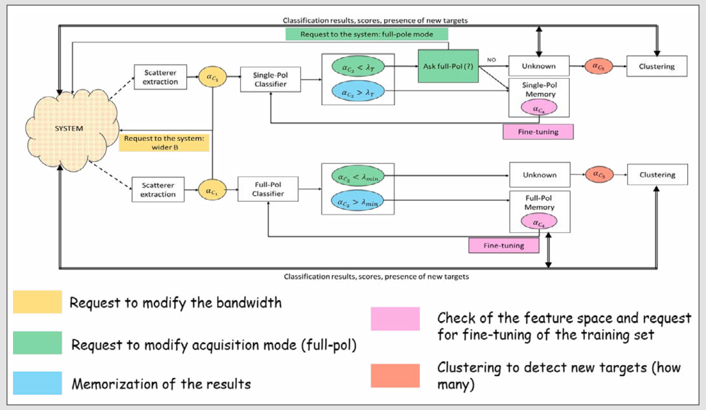
Technical Sheet
Funding institution:
European Defence Agency (EDA)
Project partners
IDS, FHR, MBDA
Project duration
January 2019 - January 2022
Involved countries
Italy, Germany



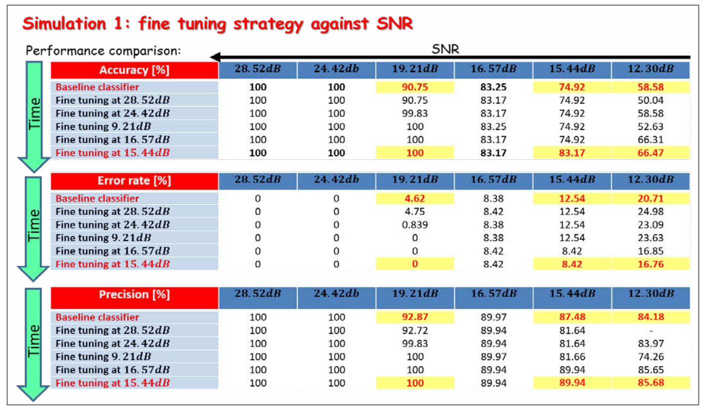
(a) Cogito conceptual idea and operative scenario



(b) Block diagram for a cognitive radar high level architecture;



(c) Cognitive architecture of the classifier.
He classifier can drive the choice of the transmitted instantaneous bandwidth, can request a full-pol acquisition, implement an on-line learning approach and can detect unknown targets;



Simulation 1: fine tuning strategy against SNR

Performance comparison: SNR

Accuracy [%]	28.52dB	24.42db	19.21dB	16.57dB	15.44dB	12.30dB
Baseline classifier	100	100	90.75	83.25	74.92	58.58
Fine tuning at 28.52dB	100	100	90.75	83.17	74.92	50.04
Fine tuning at 24.42dB	100	100	99.83	83.17	74.92	58.58
Fine tuning 9.21dB	100	100	100	83.25	74.92	52.63
Fine tuning at 16.57dB	100	100	100	83.17	74.92	66.31
Fine tuning at 15.44dB	100	100	100	83.17	83.17	66.47

Error rate [%]	28.52dB	24.42db	19.21dB	16.57dB	15.44dB	12.30dB
Baseline classifier	0	0	4.62	8.38	12.54	20.71
Fine tuning at 28.52dB	0	0	4.75	8.42	12.54	24.98
Fine tuning at 24.42dB	0	0	0.839	8.38	12.54	23.09
Fine tuning 9.21dB	0	0	0	8.38	12.54	23.63
Fine tuning at 16.57dB	0	0	0	8.42	8.42	16.85
Fine tuning at 15.44dB	0	0	0	8.42	8.42	16.76

Precision [%]	28.52dB	24.42db	19.21dB	16.57dB	15.44dB	12.30dB
Baseline classifier	100	100	92.87	89.97	87.48	84.18
Fine tuning at 28.52dB	100	100	92.72	89.94	81.64	-
Fine tuning at 24.42dB	100	100	99.83	89.94	81.64	83.97
Fine tuning 9.21dB	100	100	100	89.97	81.66	74.26
Fine tuning at 16.57dB	100	100	100	89.94	89.94	85.65
Fine tuning at 15.44dB	100	100	100	89.94	89.94	85.68

(d) An example of how the system adapts the training set against SNR variations tover time. The performances are measured in terms of accuracy, error and precision. The cognitive classifier, after the on-line learning process (last line of each table), is compared with a non-cognitive classifier (baseline classifier, first line of each table)

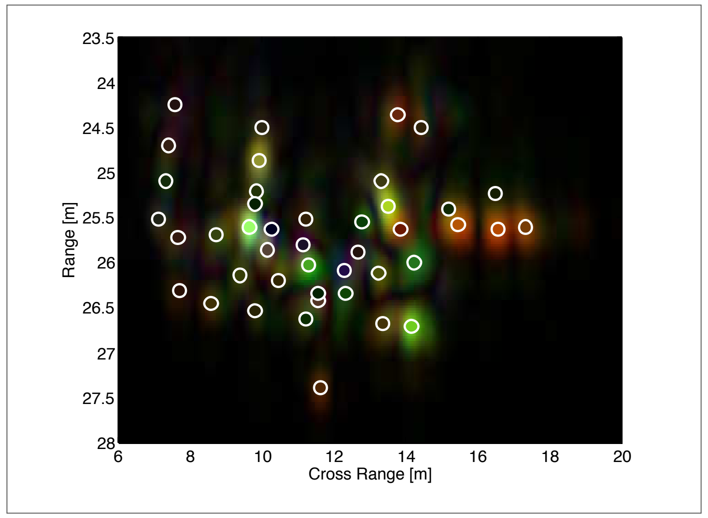
PROJECT 3D-ISAR

ATR by means of Polarimetric ISAR Images and multi-view 3D InISAR

Both homeland security and asset protection in military scenarios require high performing modern surveillance systems in terms of accuracy and response times. Examples are the protection of ports, airports, critical infrastructures, immigration monitoring and prevention, maritime and air surveillance from various types of platforms (land, sea, air and space). In this variety of applications there is the need to have a support for the recognition of the threat produced by an approaching target.
The aim of the project 3D-ISAR is twofold:

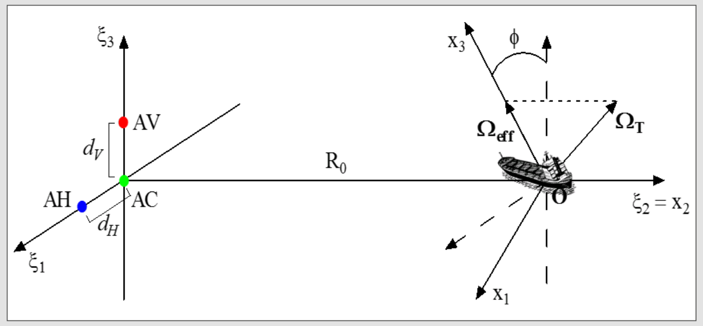
- Demonstrate that the use of polarimetry may enhance the performance of 3D Interferometric ISAR imaging systems. 3D InISAR has been proven effective to generate a 3D point target model of non-cooperative moving targets. To further enhance its performance, a fully polarimetry 3D InISAR algorithm is under development that will be able to combine the advantages of fully polarimetry radar over single polarisation radar and those of 3D InISAR over 2D ISAR imaging.
- Develop a non-cooperative target recognition algorithm that exploits fully polarimetric 3D InISAR results. The use of 3D target reconstruction instead of 2D ISAR images may overcome the problem of creating large and costly databases as 3D reconstructed images can be compared directly to geometrical target CAD models or simulated 3D e.m. CAD models. Moreover, the use of machine learning will be also investigated in this work for the implementation of NCTR algorithms.

Figure 1 shows the 3D-InISAR imaging configuration that allows for point-like 3D ISAR images to be formed. An example of the reconstruction of a 3D InISAR image is displayed in Figure 2. Figure 3 shows instead an example of a 2D fully polarimetric ISAR image of a tank. Scattering centres are extracted by applying a full-pol CLEAN technique and superimposed to the ISAR image. Finally, Figure 4 shows a high-level block diagram of the 3D InISAR imaging system followed by the application of a classifier.

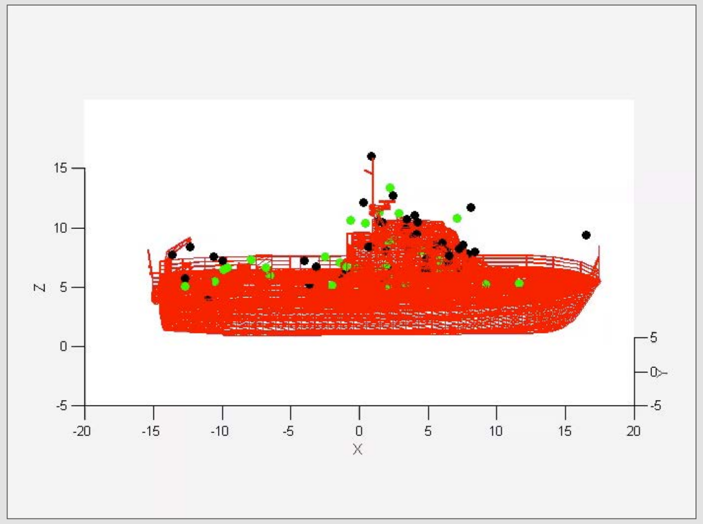


(c) 2D Fully polarimetric radar image of a tank with superimposed scattering centre estimation;

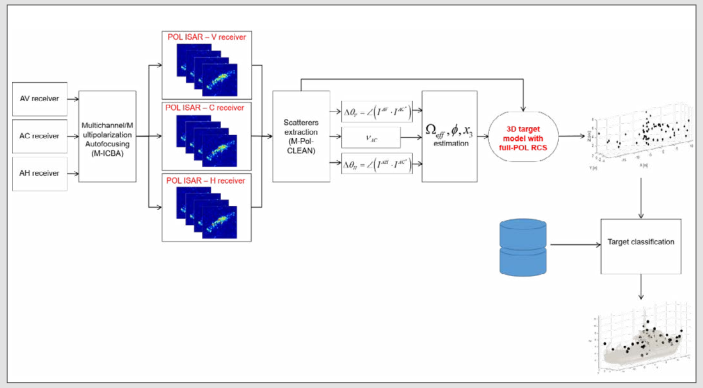
Technical Sheet
Funding institution:
ONR GLOBAL
Project partners
-
Project duration
September 2020 - September 2023
Involved countries
Italy, USA, Australia



(a) 3D-InISAR imaging configuration



(b) Example of 3D InISAR image reconstruction



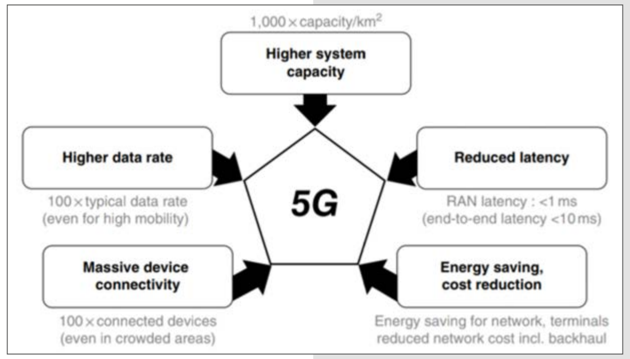
(d) An high level block diagram of the software algorithm that we be implemented. The project activities will focus on the development of the multichannel/ multipolarization CLEAN algorithm and on the development of a target classifier

PROJECT FLAIR5G

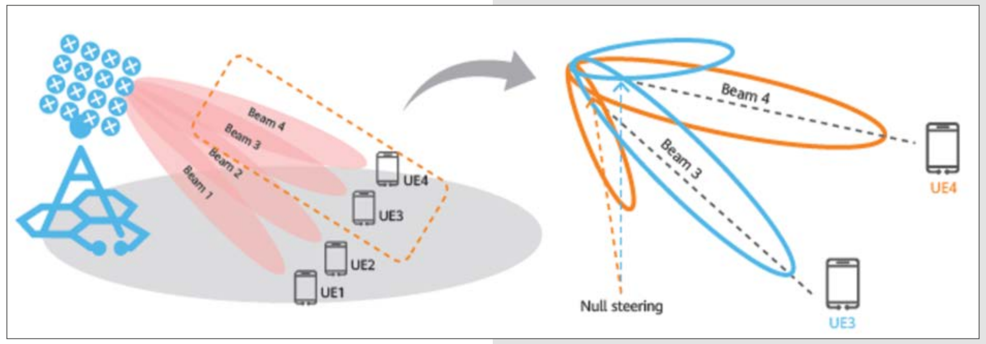
Fast Isolation Assessment

The transition to 5G involves the installation of new antennas (phased array antennas) on new sites or on existing ones.
The coverage and connectivity requirements of the 5G network and the need to share the same site (co-siting) by multiple operators implies the installation of an increasing number of antennas on the same infrastructure (pole/tower).
The reduced available space and the mechanical constraints can determine an increase in electromagnetic coupling (i.e. the reduction of isolation) among antennas with the consequent degradation of the performance of the overall system.
The aforementioned problem, as a matter of fact, determines the maximum number of antennas that can be installed on the same support and their separation distances. Therefore, the isolation assessment is a crucial task that affects the 5G wireless network deployment. Nowadays, this problem can be addressed by means of electromagnetic full-wave simulations or by measurements campaigns; both these approaches have drawbacks: the first, needs huge hardware resources due to the use of mm Waves; the second, needs a very long time due to the large number of the antennas beams directions to be tested.
The purpose of this project is to develop a novel electromagnetic method able to compute the isolation between multiple 5G antennas in order to minimize the use of full-wave simulations and measurement campaigns. The method will be implemented in a dedicated software tool to be used by RF engineers and antenna designers to analyze and to assess various antennas configurations before their installation in real environment.

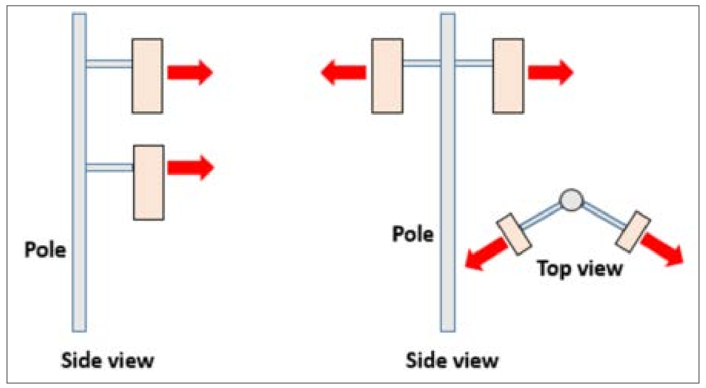
Technical Sheet
Funding institution:
Huawei Technologies Italia Srl
Project partners
University of Pisa, Netfarm srl
Project duration
June 2020 - June 2021
Involved countries
Italy



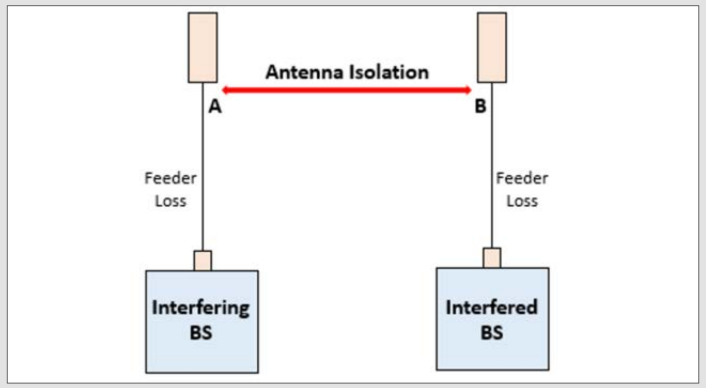
(a) Most relevant targets of the 5G mobile network



((b) Multi User beamforming accurate coverage



(c) Example of reciprocal displacements between two base station antennas



(d) Principle diagram for the definition of the antenna isolation

PROJECT GLIDE

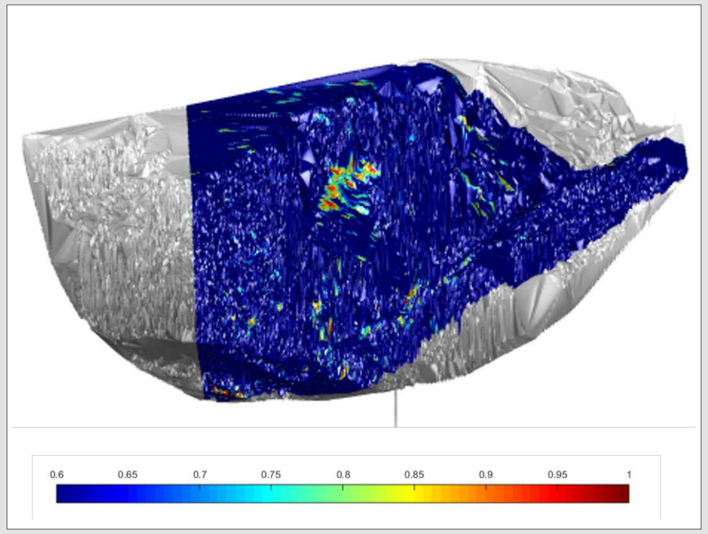
HiGhLy SensItive Radar Change Detection

The goal of this project is to significantly improve radar change detection by accurately studying the phenomenology associated with radar interferometry and by developing improved algorithms that are based on such an understanding. The main objectives to be achieved within this project are:

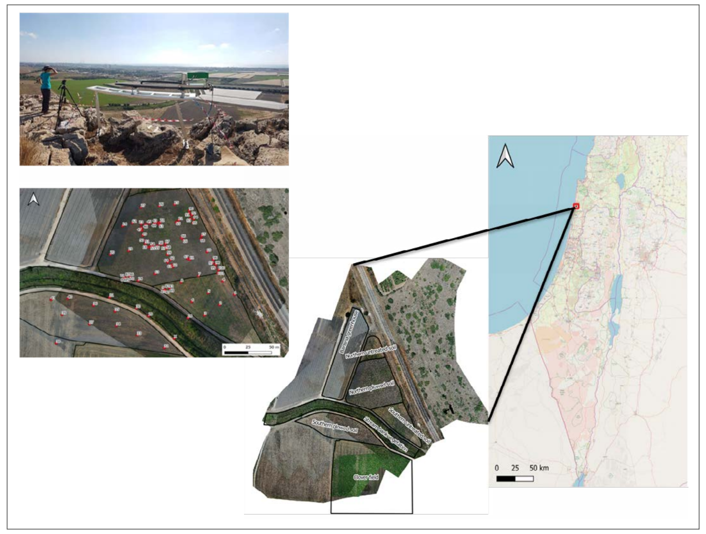
- Study the phenomenology associated with repeat pass interferometry, such as atmospheric interference, temperature and humidity variations, etc.
- Develop effective change detection and structure deformation estimation algorithms. These algorithms are based on the results of the phenomenological study in order to outperform state-of-the-art algorithms.
- Real data acquisition with a ground-based Synthetic Aperture Radar (SAR) system to support the phenomenological study and to validate the developed algorithm.
- Real data acquisition with an airborne SAR system to validate the change detection and interferometric algorithms.
- Study distributed spaceborne SAR systems as well as SAR systems based on formations of Unmanned Aerial Systems (UAS) and optimise them based on the mission goals and on the phenomenological scenarios.

The project has already seen the ground-based measurement campaign completed as well as a first phenomenological study completed. Results have shown that the newly developed mathematical models are able to significantly improve the estimation of the interferometric phase, which in turn improves the system ability to detect changes and measure millimetric deformations. Airborne radar measurements will be carried out in 2021/Q1 as well as a final algorithm validation.

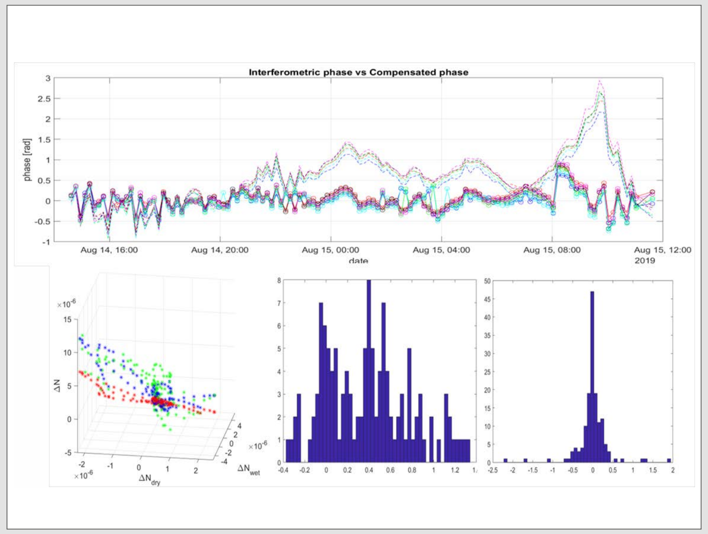
Technical Sheet
Funding institution:
Ministry of Defence
Project partners
University of Naples, ELTA Systems, ECHOES s.r.l
Project duration
February 2019 - July 2021
Involved countries
Italy, Israel



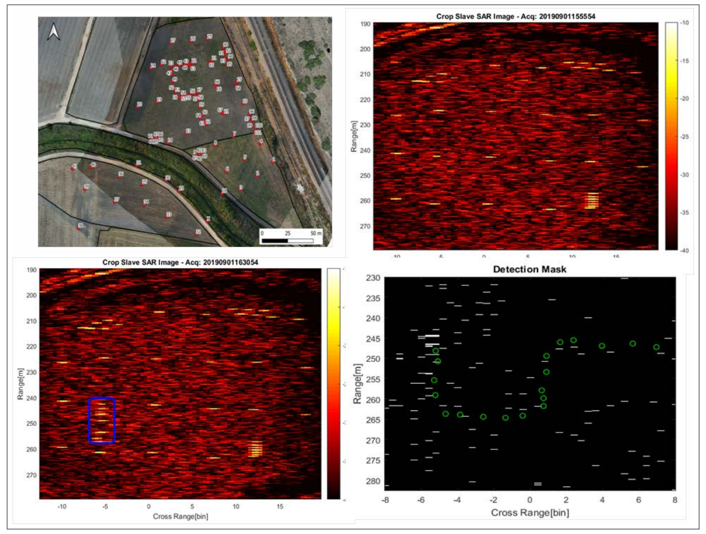
(a) Coherence map after fine Co-Registration (ECHOES s.r.l.)



(b) Ramat HaNadiv site where part of the experimental measurements were conducted



(c) Atmospheric compensation results obtained on the Israeli dataset



(d) Preliminary Incoherent Change Detection (ICD) results on Israeli dataset

PROJECT ITS-ITALY 2020

Intelligent Transportation System – ITALY 2020

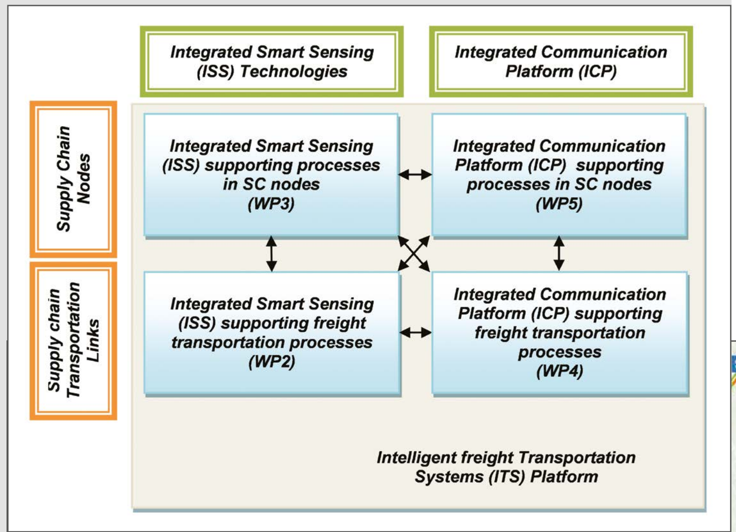
investiamo nel vostro futuro

The ITS-2020 project aims to research, design and develop innovative ICT based solutions to support logistics and transportation processes, with special attention to the inter-modal freight transportation, to improve their effectiveness and efficiency. In this context, it is very important to apply technologies based on sensors (Integrated Smart Sensing) and systems supporting the information exchange among the supply chain players (Integrated Communication Platform) for enhancing the logistics process in its base components, namely ‘nodes’ (e.g. ports and inter-ports) of the supply chain and transportation ‘arches’. To this aim, the project has been structured into seven work packages (WPs) whose main research areas are:

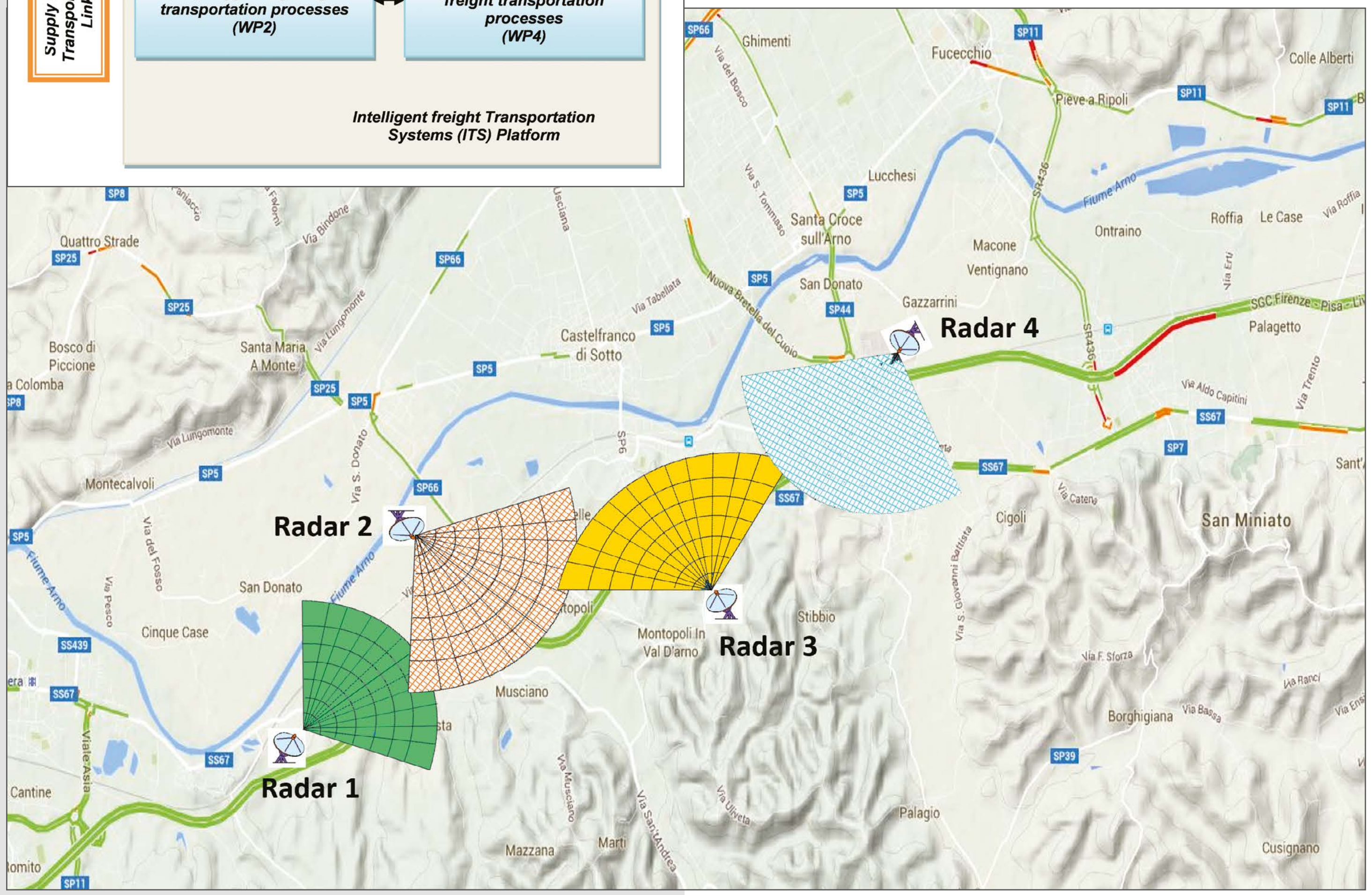
- Development of integrated smart sensing solutions to support both transport and node processes
- Development of data communication system solutions to support both transport and node processes

The main result of the project will be the development of effective tools able to integrate traditional services, i.e. transportation and warehousing, with information-based services, such as information transfer, route planning, monitoring (i.e. tracking and localization). In the framework of ITS-ITALY project, CNIT-RaSS proposes a radar systems network for vehicle monitoring and classification based on radar images. The processing architecture and the proposed algorithms have been validated through real data acquired during the experimental phase.
Project web-site: http://51.89.224.112/itsitaly2020/

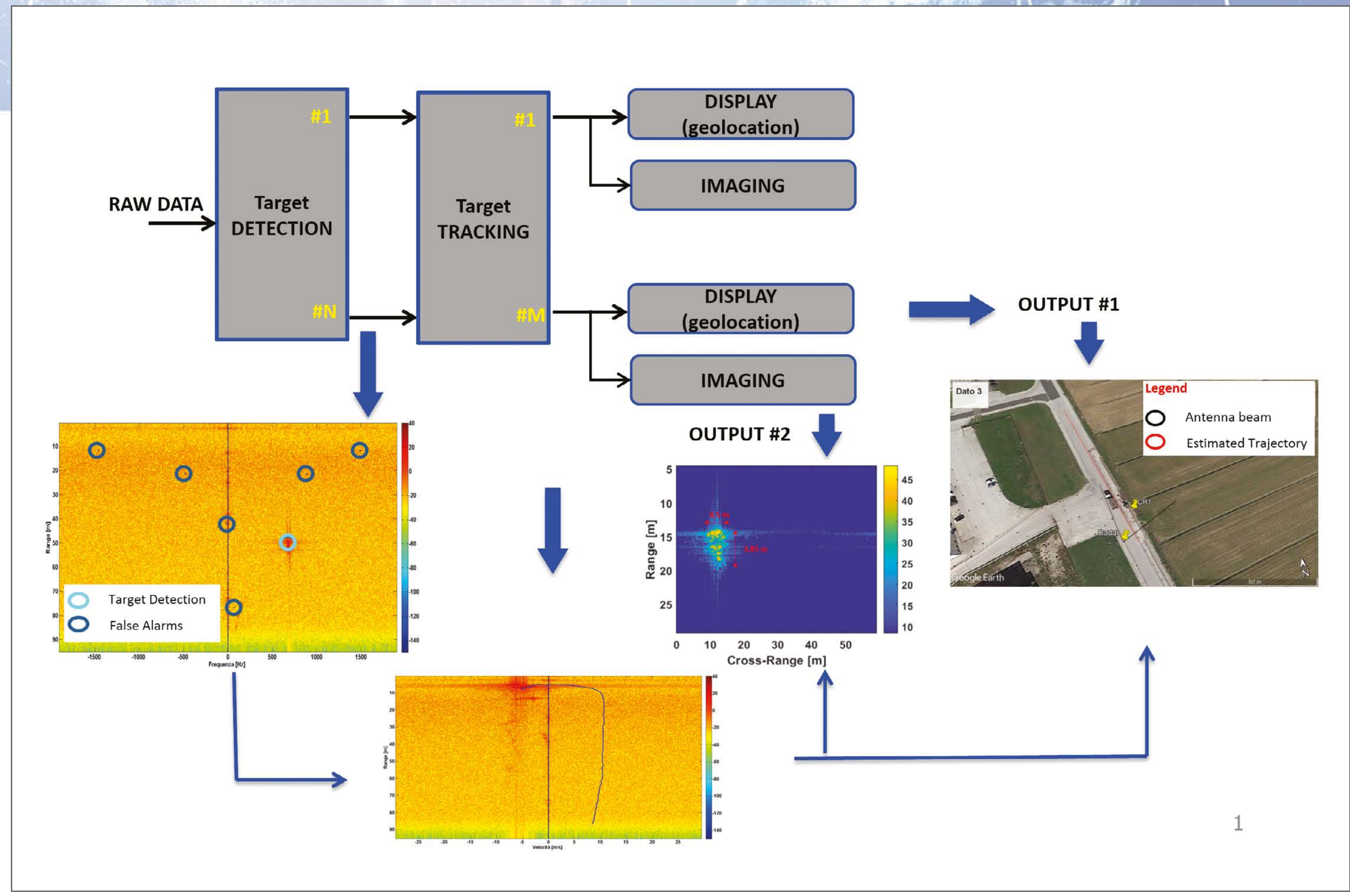
Technical Sheet
Funding institution:
MIUR
Project partners
POLIMI, POLITO, Softeco Sismart, TESI, Mobysys, Gruppo SIGLA S.r.l., Almaviva, RDW, Rotas Italia S.r.l., IVECO S.p.A., IDNOVA S.r.l., IB S.r.l., Aitek, TELECOM, Exprivia, Gianetti Ruote, IDS, STAR, VITROCISET, OPTISOFT, ART S.p.A., HUPAC
Project duration
February 2014 -February 2021
Involved countries
ITALY



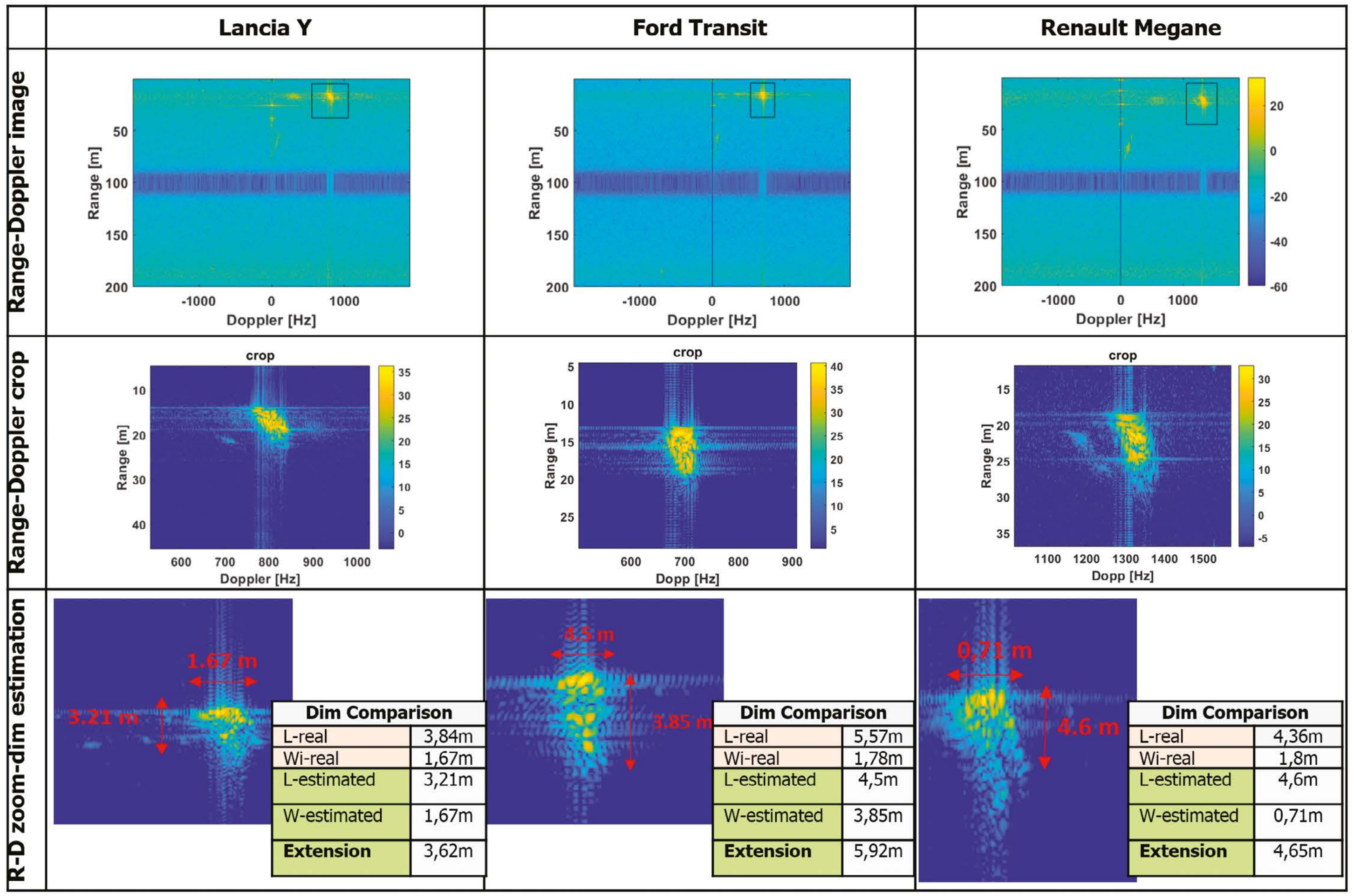
(a) - ITS concept architecture



(b) - Network of sensors for the surveillance of wide areas and the localization of freight transports



(c) - Processing Block Diagram and relative output



(d) - Results of vehicle classification based on radar images

PROJECT MIRACLE II

In background surveillance there is a need for near-global coverage at medium temporal and spatial resolution. In targeted operations, there are similar needs for localized coverage at a very high temporal and spatial resolution. The objective of this project is to cover both needs through:

- Virtual SAR constellations
- Cluster of real SAR satellites

in combination with new SAR technology both on the instrument and processing side.

The application scenarios for the project will be maritime security and defence applications in the Mediterranean and High-North areas. In surveillance and security, our assets should maximise the following operational performance characteristics:

- Spatial coverage
- Temporal coverage
- Spatial resolution
- Low vulnerability
- Timeliness

Current assets, including the way they are used, are not able to meet user needs and requirements in an optimal manner.

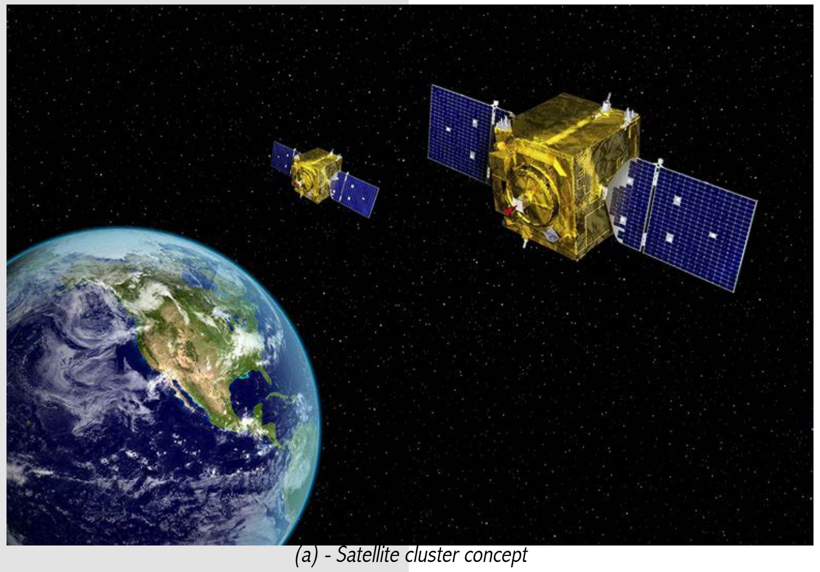
During this project, we will analyse new and forthcoming technologies to provide increased performance of future assets and optimal use of existing assets at an affordable cost. The following key elements will be analysed:

- SAR Cluster of small, relatively inexpensive satellites
- New SAR technologies
- Virtual SAR cluster utilizing existing and future SAR missions
- Maritime modes, including optimal ship detection and imaging

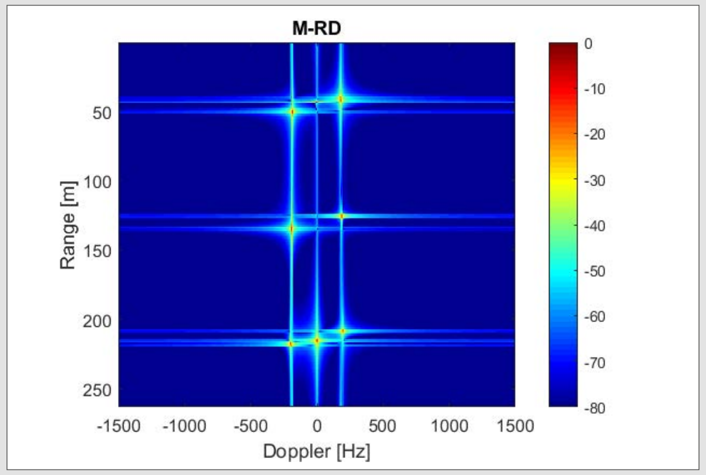
In this project we:

- Propose an architecture for such constellations
- Demonstrate technical solutions and key technologies
- Demonstrate the value for military users.

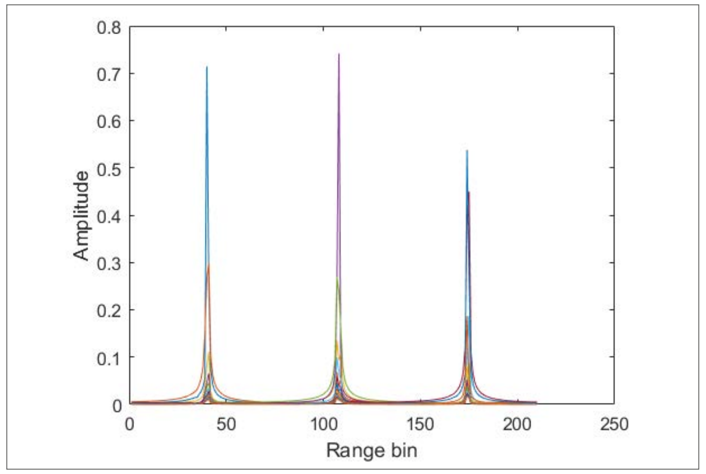
Technical Sheet
Funding institution:
European Defence Agency (EDA)
Project partners
Kongsberg, FFI (Norwegian Research and Defence Establishment), Università La Sapienza
Project duration
January 2018 - December 2020
Involved countries
Italy, Norway



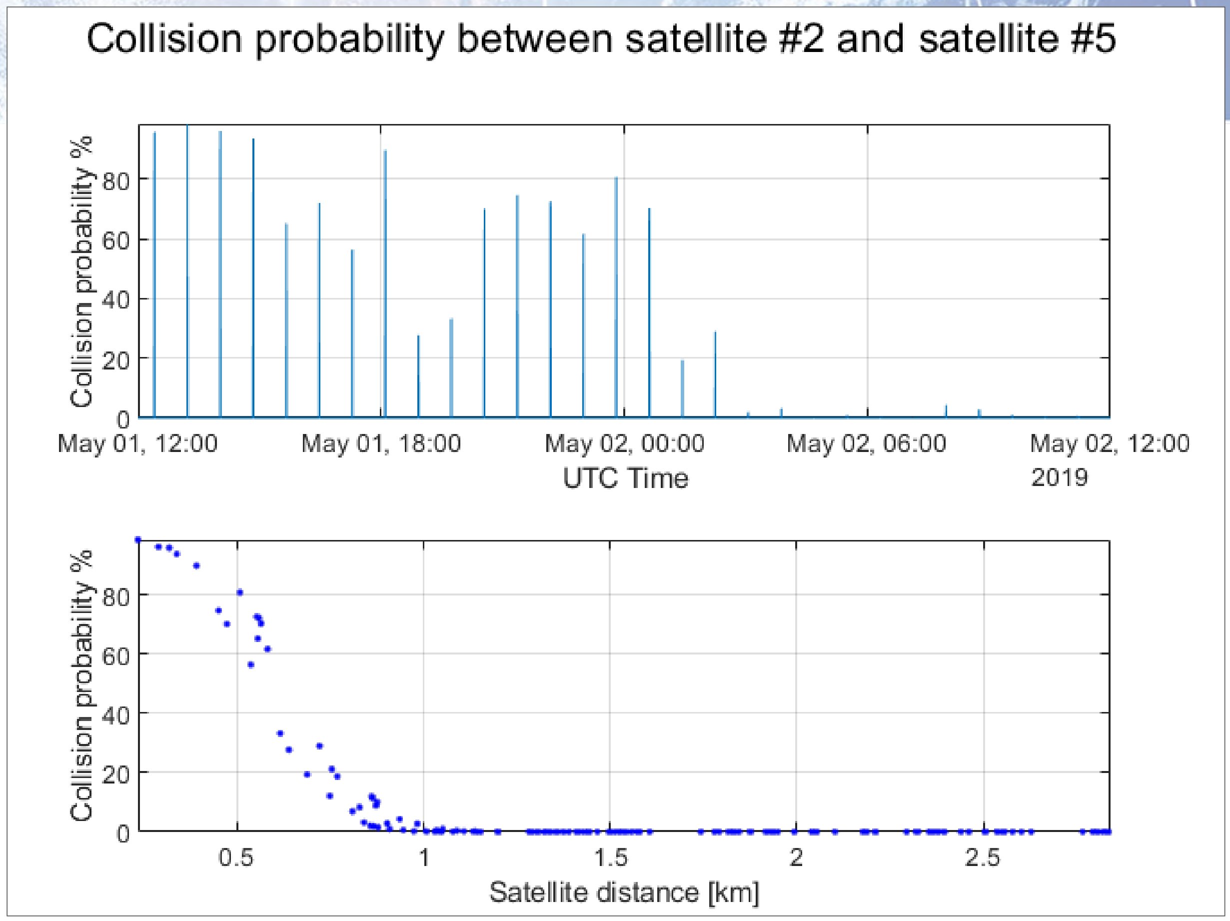
(a) - Satellite cluster concept



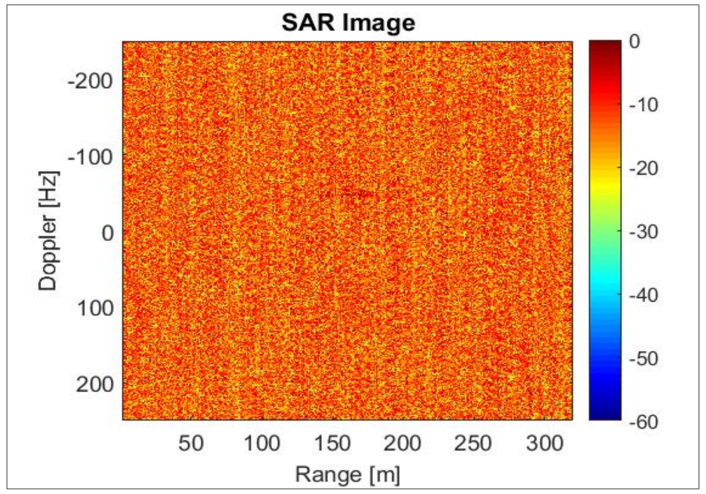
(b) - Multichannel image formation with baseline length equal to 1.5 cmmultichannel range Doppler



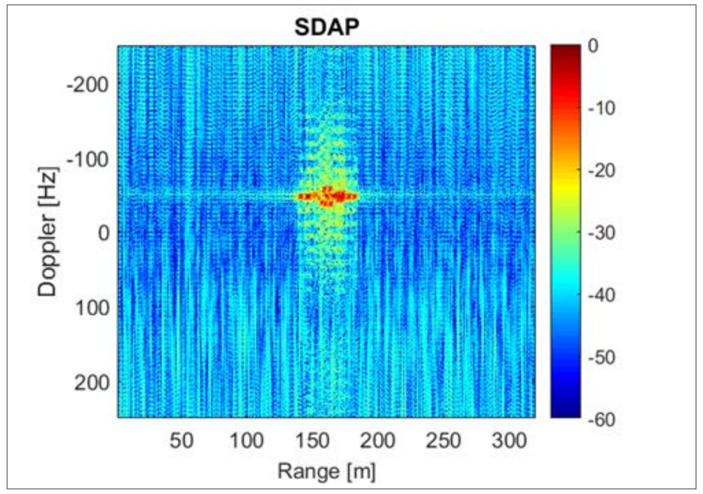
(c) slice along range dimension for a set of Doppler frequencies



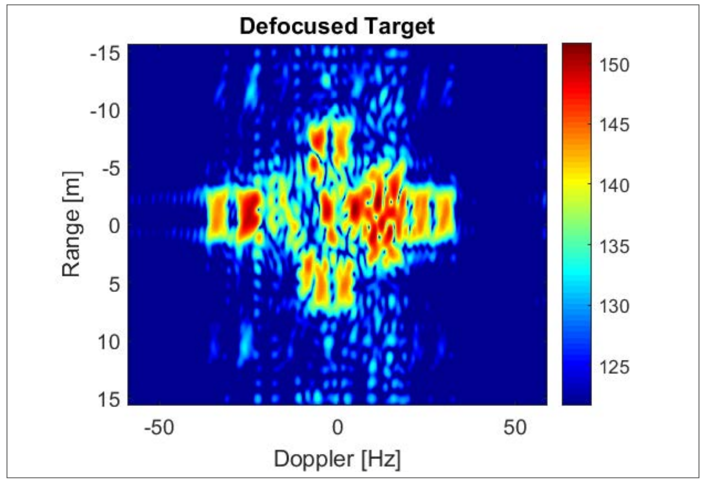
(d) Collision probability percentage value between two satellites in configuration for critical orbits in case of ground-based positioning, having standard deviation <?>



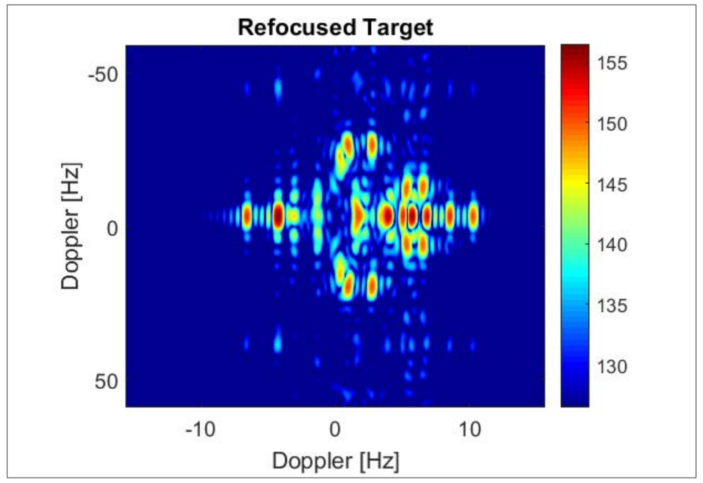
(e) Multichannel RD SAR image before STAP processing



(f) Multichannel RD SAR image after STAP processing



(g) SAR image before ISAR processing in which only the SAR motion is compensated and a mismatch between SAR and moving target is present



(h) SAR image in which the target motion is compensated by applying ISAR processing

PROJECT NORMA

NOise imaging Radar network for covert air and MAritime borders Security

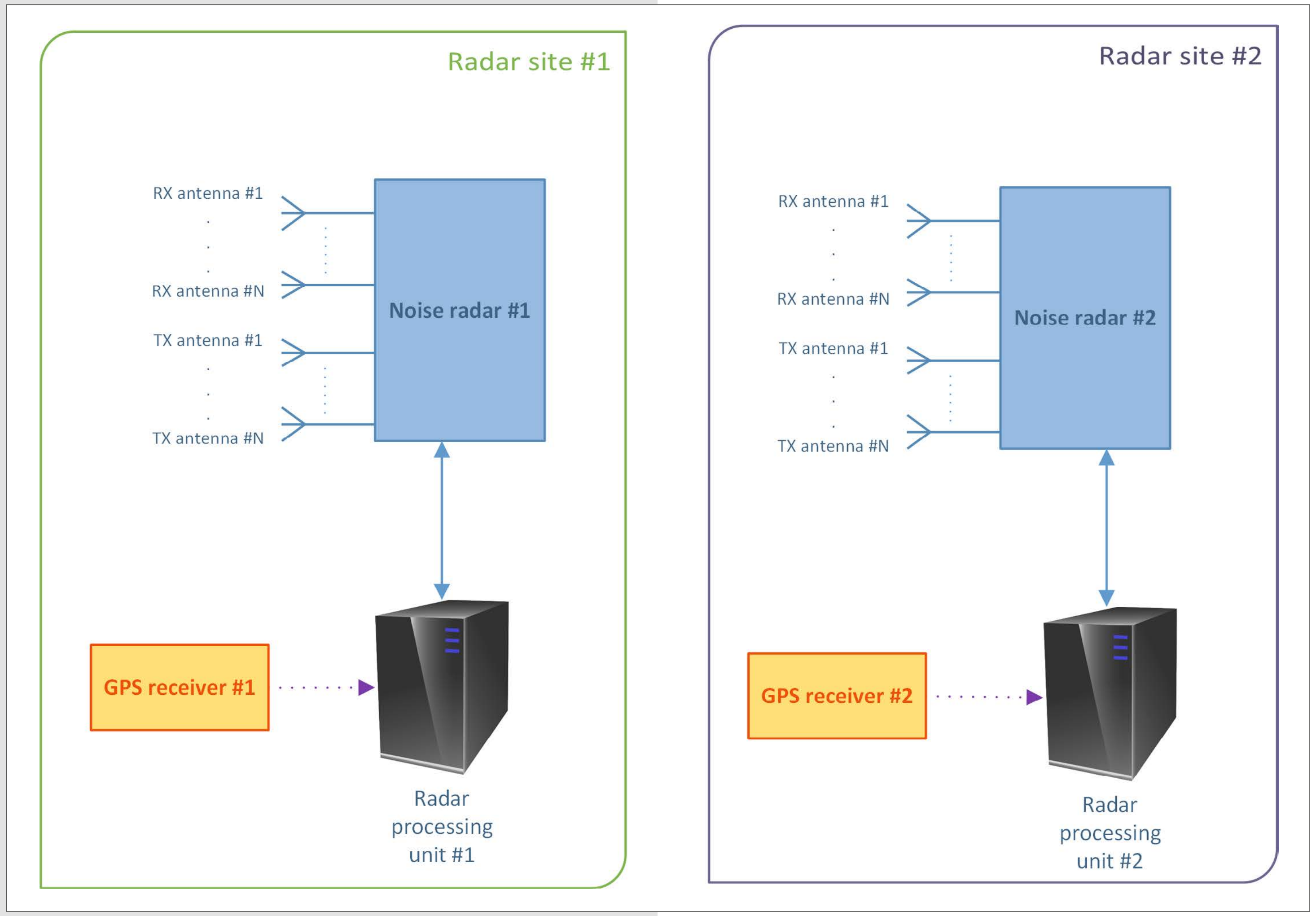
The project proposes the study, design, analysis and demonstrator realization of a wideband noise imaging radar network for air and sea border surveillance. The single radar sensor will be designed to work in three different modes: target RCS measurement, high range resolution profiling (HRRP or 1D imaging) and 2D-SAR and ISAR imaging. The main novelties of the NORMA system are:

- Use of random/noise and noise-like waveform which enables Low Probability of Intercept (LPI) characteristic and, hence, covert surveillance operational mode,
- Radar imaging capability with noise waveform, more specifically, high resolution range profiles and 2D- images of targets to be used for recognition and classification
- Ability to transmit stepped frequency continuous waveforms, which enable the detection of slow aerial (especially drones) and sea target in strong clutter environment
- Advanced signal processing, which provides the ability to detect targets floating in sea clutter environment
- Radar network, which enables bistatic, multistatic and Multiple Input Multiple Output (MIMO) RCS and 1D- 2D imaging for better target characterization and identification

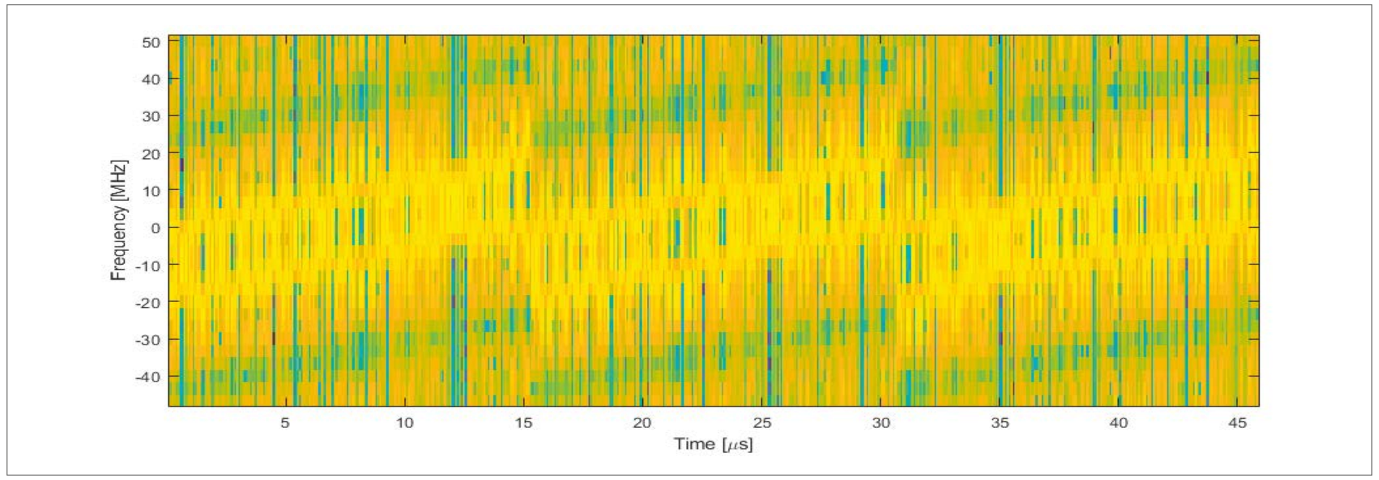
A technological demonstrator composed of a network of two noise imaging radar systems will be designed and developed.

The demonstrator will be designed to produce monostatic and bistatic, RCS measurements, high range profiling and 2D ISAR imaging. Test and validation will be performed in two scenarios: 1) The surveillance of the Russian-Ukraine air border around the area of Kharkov, as a practical real problem; 2) The surveillance of the sea area around the Livorno harbour (Italy) for monitoring illegal and threatening activities. Special attention will be paid to the detection of floating small size objects in sea clutter.

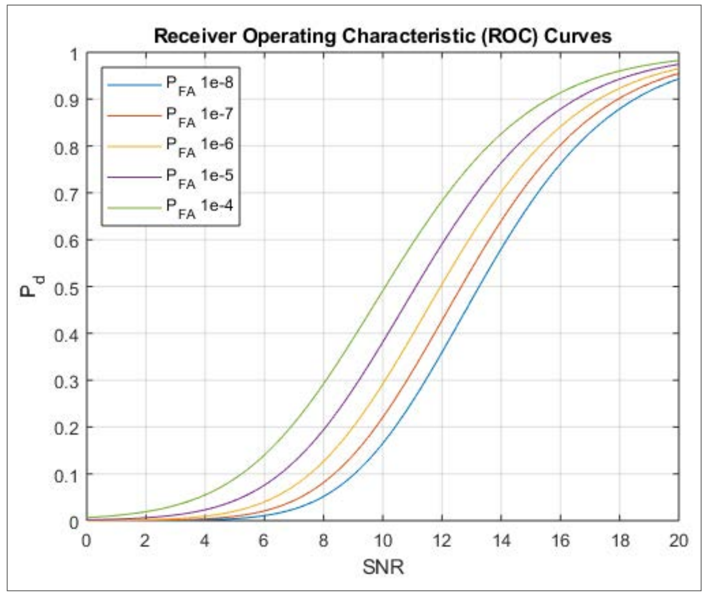
Technical Sheet
Funding institution:
NATO Emerging Security Challenges Division, SPS Programme
Project partners
IRE NASU with the participation of Echoes s.r.l
Project duration
May 2018 - May 2021
Involved countries
Italy, Ucraine



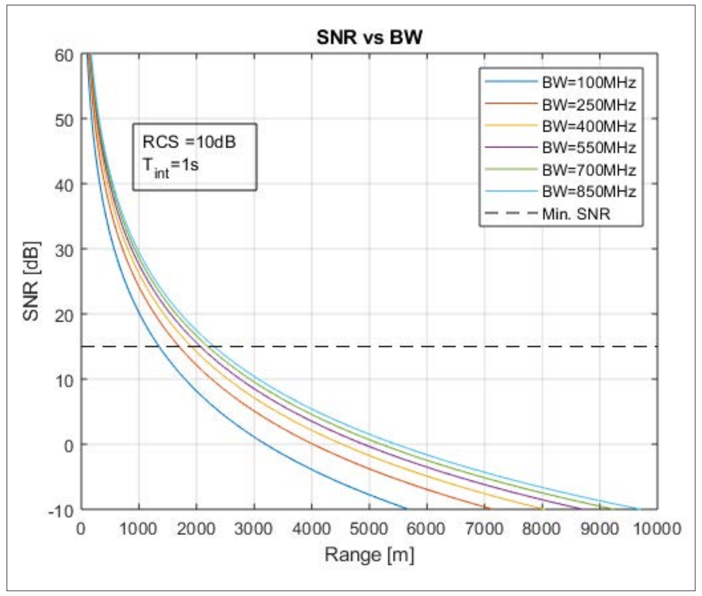
(a) - NORMA high level system architecture including two noise radars



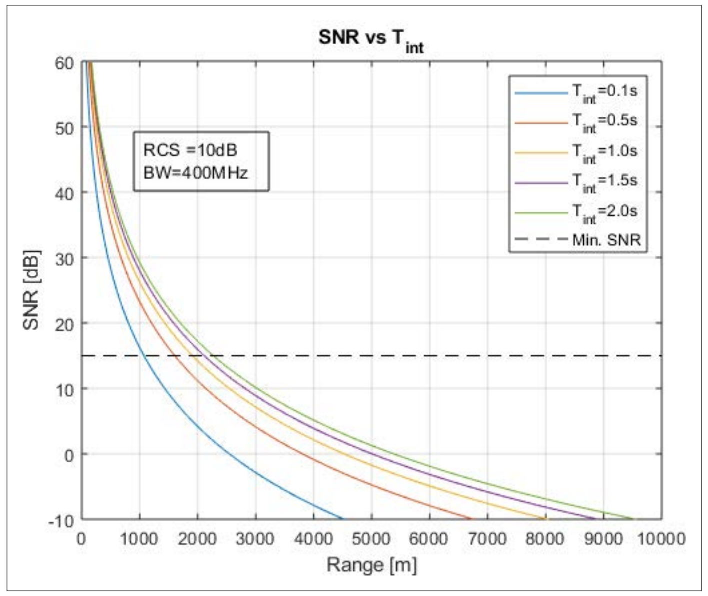
(b) PRBS (pseudorandom binary sequences) modulated FMCW waveform, 30MHz noise bandwidth. The typical "ramp" of FMCW signal is completely masked by the noise, leading to pseudo random noise like waveforms and, hence, LPI operations



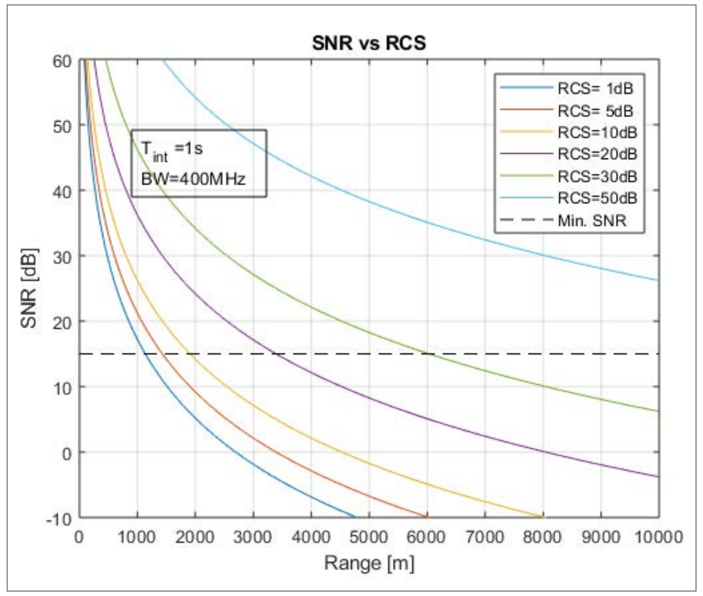
(c) ROC curves for Swerling III model



(d) SNR with respect to range distance with the varying of the target RCS



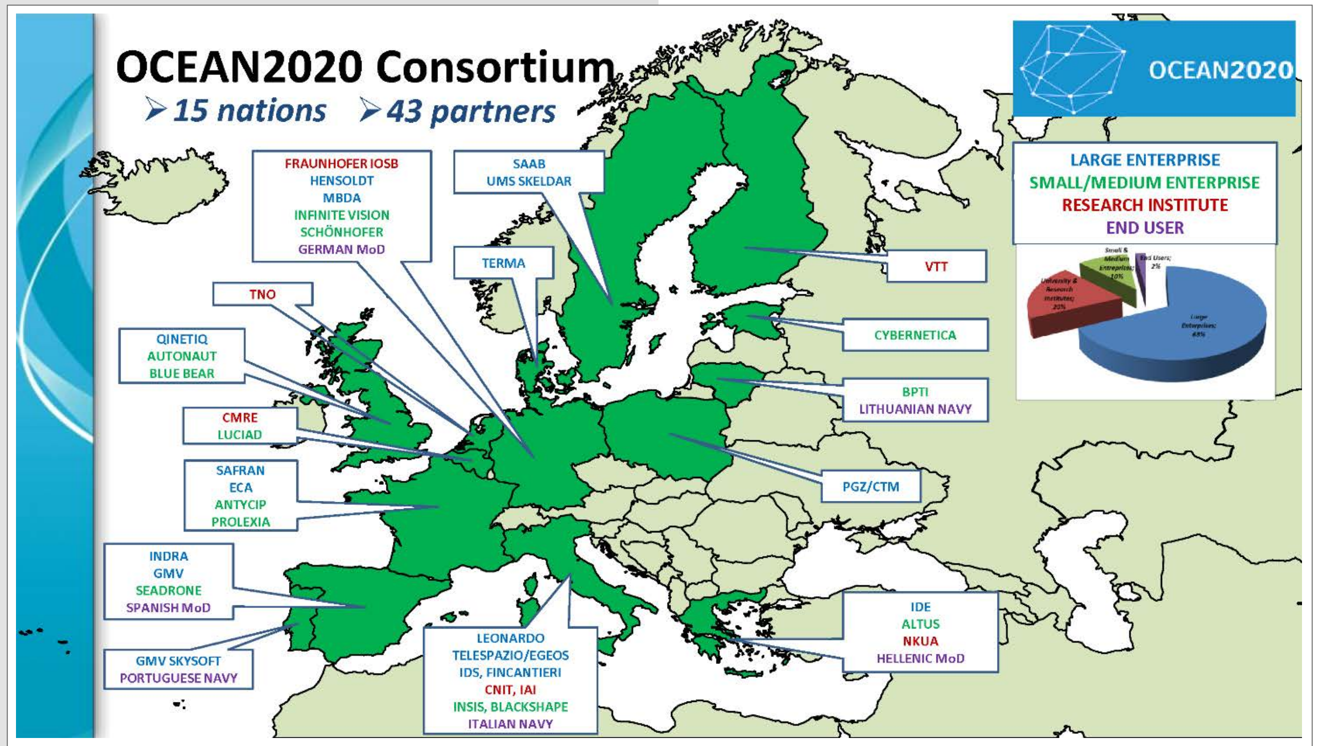
(e) SNR with respect to range distance with the varying of the coherent processing interval



(f) SNR with respect to range distance with the varying of the transmitted waveform bandwidth

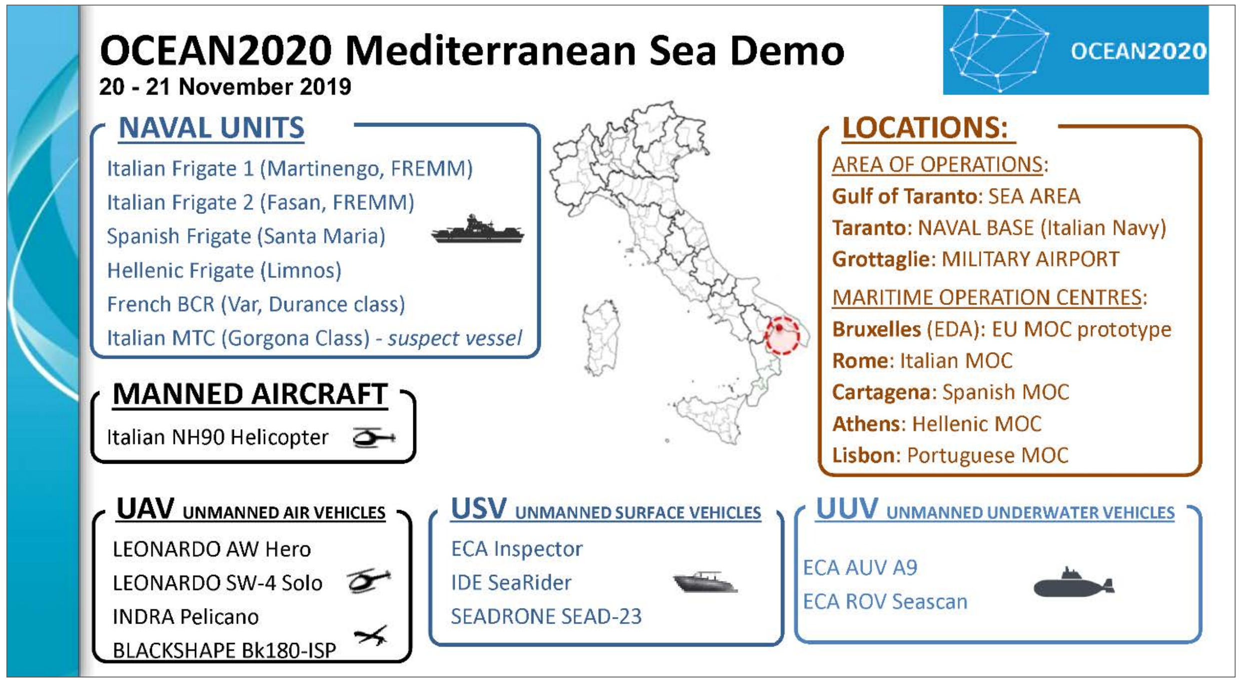
OCEAN2020 project has been conceived in the framework of the Preparatory Action on Defence Research (PADR), in the Research Action call on Unmanned Systems, focusing on the topic of Technological demonstrator for enhanced situational awareness in a naval environment.
The OCEAN2020 project will allow the enhancement and the integration of various types of unmanned platforms (fixed wing, rotary wing, surface and underwater) with the command and control centre of the naval units, providing for the data exchange via satellite with command and control centres on the ground. The joint and cooperative use of both pilot and unmanned platforms will also be demonstrated during the project. These innovative capabilities will be used for surveillance missions and maritime interdiction.
OCEAN2020 put together the specialists of technologies relevant to the sea domain for observing, orienting, deciding and acting naval operational tasks in maritime scenarios (from major Research Institutes, through Large and SME industries till the NATO Center of Excellence for Maritime Research and Experimentation) and fourteen countries representative of European northern and southern seas along with their relevant defense and security needs.
In very few words, all above represents the inclusive strength that OCEAN2020 intends to leverage to pave the way towards the future EU Defence Research Window and Capability Window, by integrating legacy with new technologies concerning unmanned systems, ISTAR payloads, lethal and non-lethal effectors and by exploiting data from multiple sources, including satellite assets, into a Standardized Maritime Picture, to secure a naval/maritime dominance.

Technical Sheet
Funding institution:
EU
Project partners
Leonardo S.p.A, Sistemi Dinamici, Swidnik Spolka Akcyjna, NATO Centre for Maritime Research and Experimentation, Indra, Fraunhofer IOSB, Saab Akitebolag, Saab Kockums, Saab Dynamic, Dockstа Shipyard, Osrodek Badawczo-Rozwojowj Centrum Techniki Morskiej S.A., Safran Electronics & Defense, Intracom, Defense Electronics, TNO Defence Research, QinetiQ Ltd., Baltijos Pazangiu Technologiju Institutas, GMV IS Skysoft, MBDA Deutschland GmbH, MBDA Italy, IDS Ingegneria dei Sistemi, GMV Aerospace and Defence, Terma A/S, ECA Robotics, Fincantieri S.p.A., CETENA, e-GEOS S.p.A., Telespazio, VTT Technical Research Centre, Cybernetica AS, UMS Skeldar Sweden AB, Seadrone, AutoNaut Ltd, Blue Bear Systems Research Ltd, National and Kapodistrian University of Athens, Prolexia, Schönhofer Sales and Engineering GmbH, Antycip Simulation SaS, Infinite Vision GmbH & Co. KG., Insis SpA, Altus LSA, Luciad NV, Istituto Affari Internazionali, Hensoldt Sensors GmbH, Blackshape S.p.A., Marina Militare Italiana, Lithuanian Navy, Hellenic Ministry of Defence, Portuguese Navy, Spanish Ministry of Defence
Project duration
January 2018 - March 2021
Involved countries
Italy, NATO, Spain, Germany, Sweden, Poland, France, Greece, Netherlands, UK, Lithuania, Portugal, Denmark, Finland, Estonia, Belgium

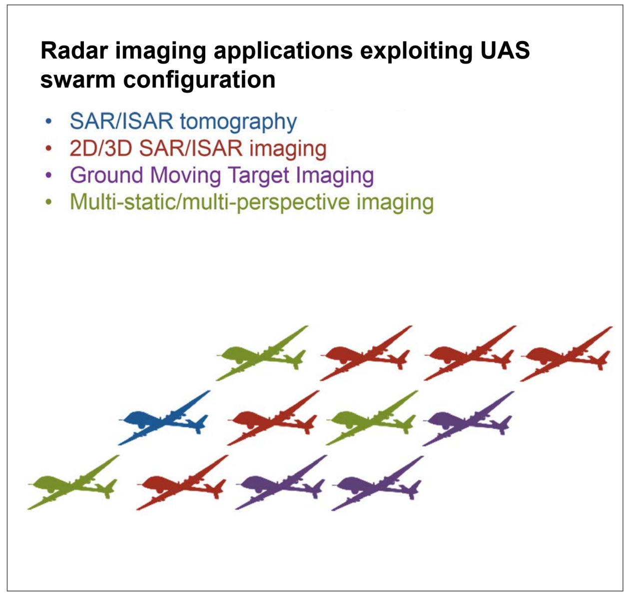


(a) OCEAN2020 project consortium

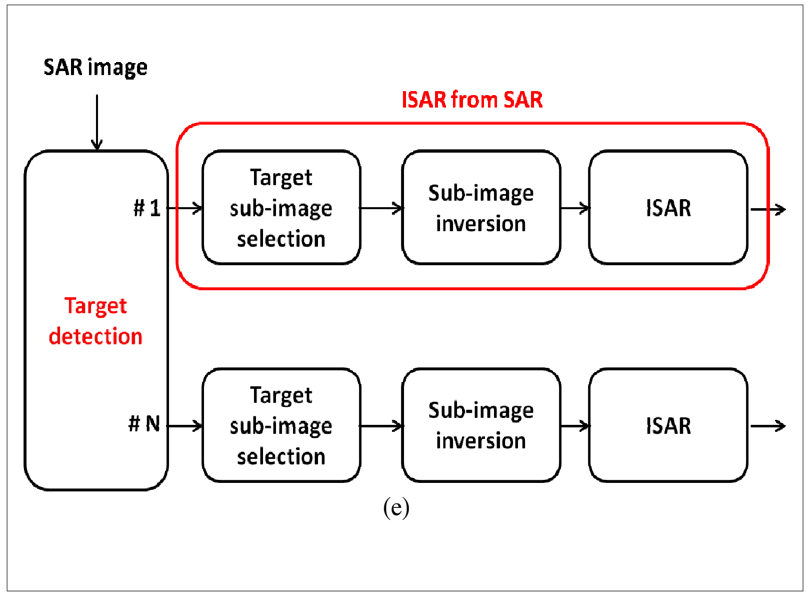
(b) Unmanned systems participating at the trials



(c) OCEAN2020 Mediterranean sea demo details



(d) OCEAN2020 – Sketch of radar imaging applications on UAS swarm



(e) ISAR from SAR Functional Block

PROJECT POSEIDON

A compact combined UaV Polarimetric Ku band radar and EO/IR sensor system for oil spill and sea debris detection

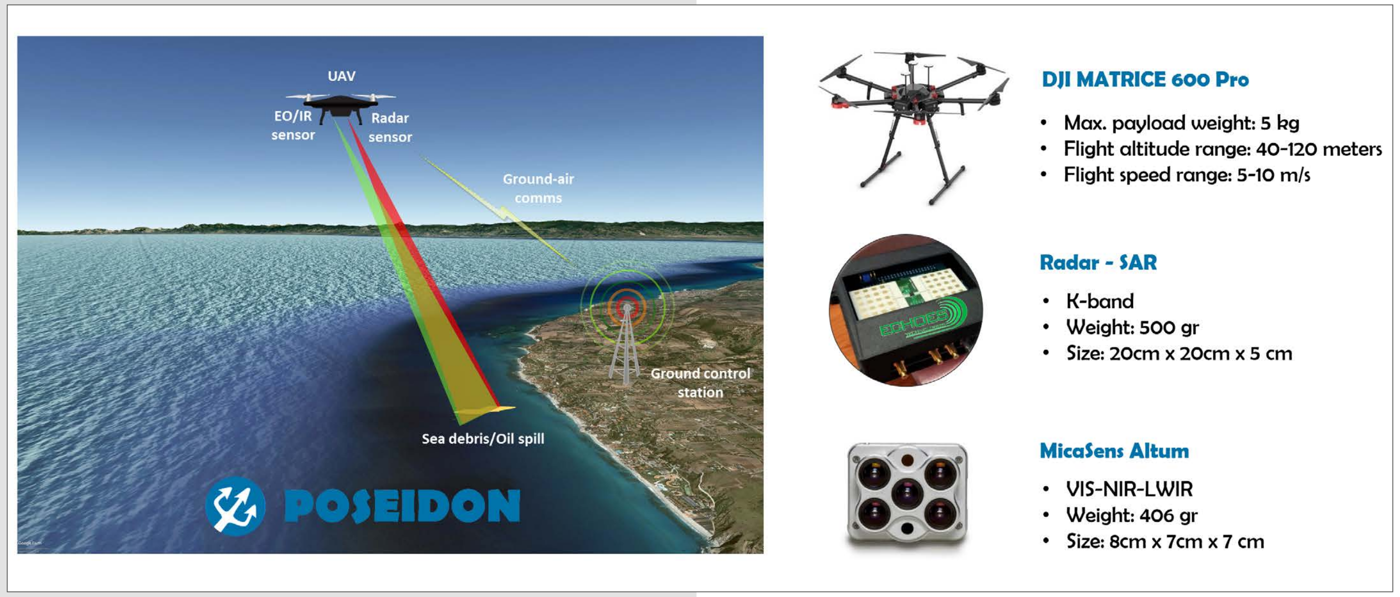
POSEIDON aims to protect sea life by designing an efficient response for the alarming rise of maritime pollution and its consequences. This is realized by making use of a compact multi-sensor system carried on UaVs equipped with radar sensors jointly operating with EO/IR cameras, which are able to effectively detect sea debris and oil spills.
Sea pollution is an issue that has attracted the attention of researchers worldwide in the last decades. The amount of pollution has been increasing in the last few years, posing a serious threat for marine life as well as affecting boats and the coastal ecosystem. Deliberate or accidental, disposal of man-made waste, such as fishing nets and plastic bags among others, as well as oil spills from large vessels, are two of the main sources of marine pollution.
POSEIDON aims to contribute with the provision of an efficient, innovative and expertly designed response to the alarming rise of marine pollution and its consequences.
The main novelties of the proposed system are:

1. Design of a compact, light and fully polarimetric radar with SAR imaging capabilities. The radar system is a 24/7, all weather surveillance sensor with enhanced capability of detecting floating debris and oil spills thanks to polarimetry and high spatial resolution.
2. Use of EO/IR sensors for a better identification of the type of debris and the extension of the oil spill to help the coordination of a prompt response for the mitigation of the problem.
   To this end, recent advances in deep neural networks for object detection, segmentation, and classification will be explored. Application and development of ad-hoc fusion techniques for the two sensors to jointly operate in the same platform.

Project web-site: http://poseidon.cnit.it/

POSEIDON

Technical Sheet
Funding institution:
MarTERA ERA-NET COFUND (EU) MIUR (IT) *Ministerio de Economia Y Empresa (SP)*
Project partners
CARTOGALICIA
Project duration
May 2018 - October 2021
Involved countries
Italy, Spain



(a) - POSEIDON system and its main components

(b) POSEIDON system. The drone payload (EO/IR camera, radar sensors IMU system and GPS antenna) has been integrated successfully in the DJI matrice 600 pro

(c) A detail of the integration showing the radar antenna and EO/IR camera pointing toward the same direction

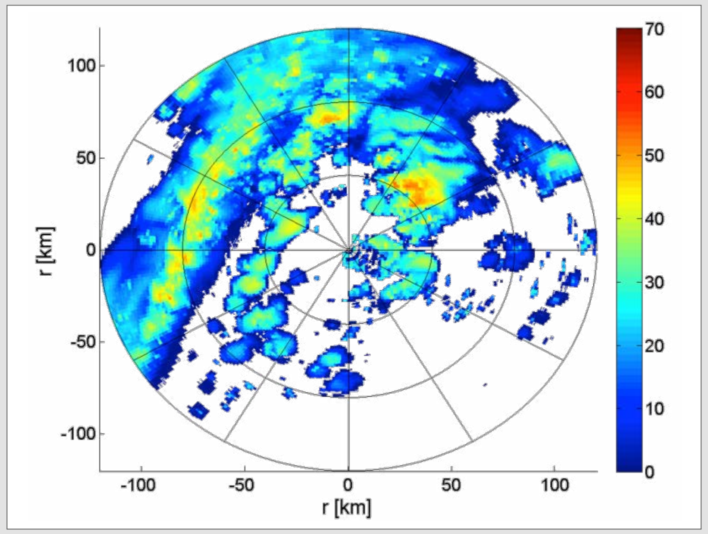
(d) First flight of the POSEIDON system to test the system integration and endurance before measurements

PROJECT POWER

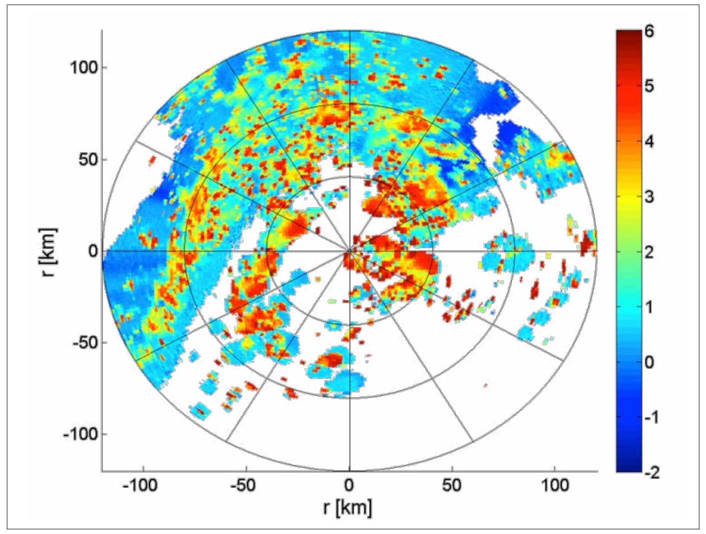
POlarimetric WEather Radar SW simulation tool

The Polarimetric Radar Signal Simulation Software is a powerful tool to simulate realistic radar returns as observed by a Polarimetric Weather Radar. The software generates I/Q signals as if they were produced by a weather radar installed aboard an aircraft moving through a meteorological scenario or a by a ground-based radar observing a distant phenomenon. The software also includes the possibility to simulate clutter generated by the underlying sea or terrain, for which several models are available. The software addresses two main aspects in the evaluation of the I/Q signals: Microphysical: according to both their nature and related mesoscale data, particles are assigned a DSD (Drop Size Distribution) and speed due to winds. Electromagnetic: according to their nature and phase state, particles are characterized in terms of backward and forward propagation complex amplitudes. The software offers the possibility to simulate different environments taking into account liquid and solid hydrometeors alike, with their distinctive polarimetric behaviour. The software processing suite offers also a separate toolbox used to estimate the principal radar observables: Absolute Reflectivity, Differential Reflectivity, Specific Differential Phase, Correlation Coefficient and Linear Depolarization Ratio. Additionally, the simulated data can be used to estimate principal spectral features: Range- Doppler map, Wind map, Spectrum width.

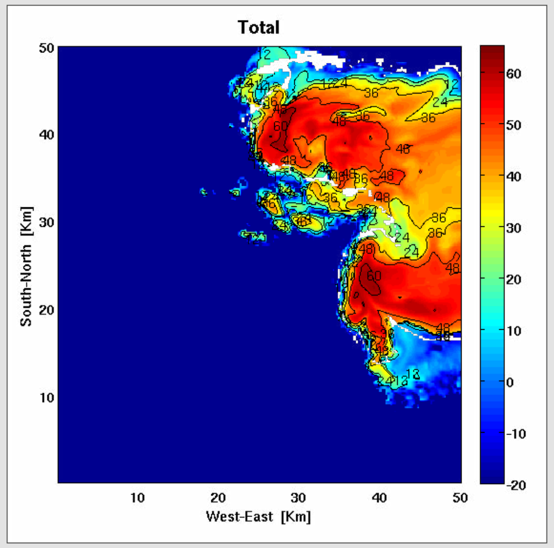
Technical Sheet
Funding institution:
Civil Aviation University of China
Project partners
University of Florence
Project duration
November 2019 - November 2020
Involved countries
Italy, China



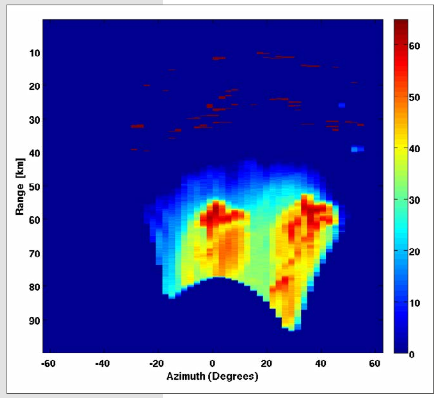
(a) Example of simulated Horizontal reflectivity



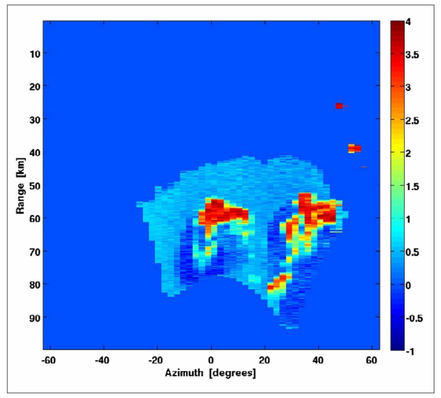
(b) Example of simulated differential reflectivity



(c) Horizontal reflectivity for a supercell.
The yellow arrow is the plane flight direction



(d) Horizontal reflectivity simulated for the on board polarimetric radar assuming the airplane position view of (c)



(e) Differential reflectivity simulated for the on board polarimetric radar assuming the airplane position view of (c)

PROJECT RING

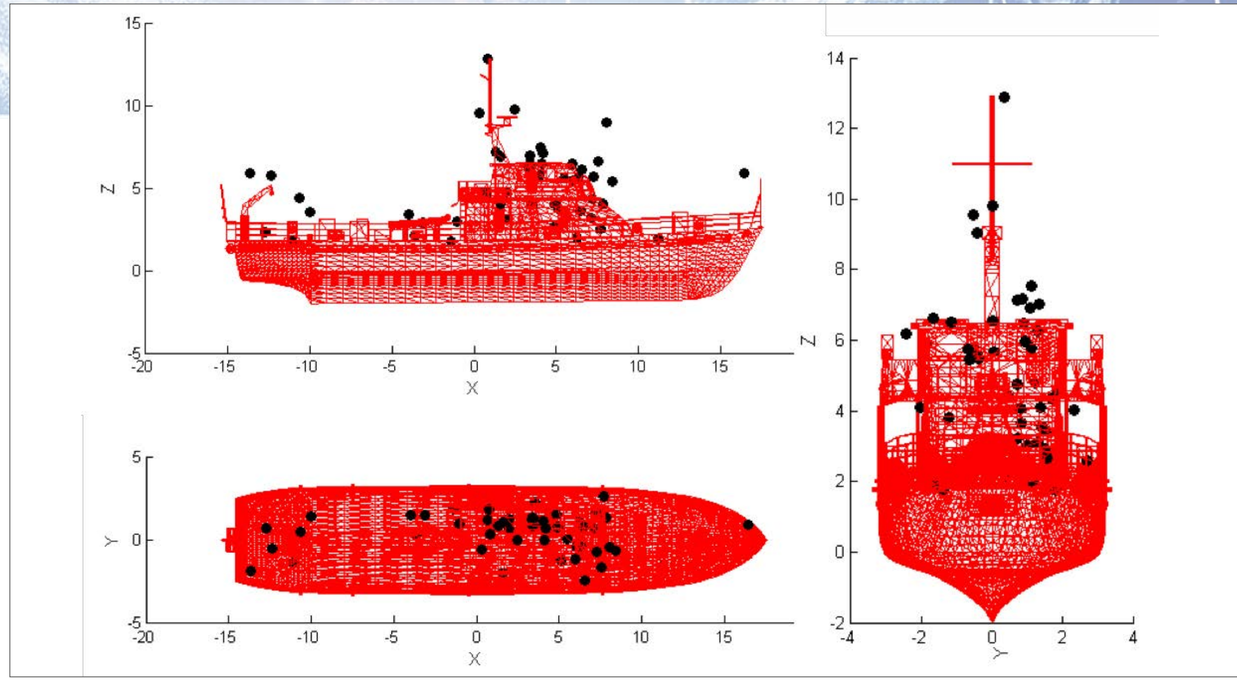
RING aims at developing a new system for Non-Cooperative Target Recognition (NCTR) based on 3D radar imaging.
The core of this project is the development of a system for 3D radar image formation based on the use of a dual orthogonal baseline interferometric radar and the associated target recognition architecture and algorithms.
The operative needs that have led to this proposal concern both tactical and strategic operations where target identification is a required capability. Use of this technology has also been considered in scenarios of civil/homeland security.
State-of-the-art radar systems employ a basic target recognition system, which is based on an identification friend of foe (IFF) approach. This technology, though, is based on target's cooperation. Some modern systems employ noncooperative target recognition systems that are based on the use of 2D radar images, mainly Inverse Synthetic Aperture Radar (ISAR). 2D ISAR images, unfortunately, suffer of several issues, which may be overcome by employing 3D radar imaging technology. 3D information of a target, in fact, leads to a more refined target identification and prioritization for operational and tactical purposes. The precise target identification can be used for recognizing and prioritizing detected target. For example, the developed technology will provide vital information, including cases where it must be decided whether a detected target can be treated as an attacking plane, or whether it is fighter or bomber (with precise brand assignment), if it is armed (in case of externally attached missiles or bombs), and so on so forth. This project aims at developing and validating such technology to make it available to future radar systems.
The proposed technology could also be used in homeland security scenarios, in order to enhance maritime and border surveillance where it is important to recognize and classify detected targets.

Examples are the protection of ports, airports, ships, critical infrastructures, coastal control, immigration monitoring and prevention, including maritime, air and space surveillance from different types of platforms (ground, naval, air and space). In all aforementioned applications, there is the need to recognize a threat produced by a non-cooperative target, which can be significantly enhanced by using recognition techniques based on a novel 3D radar imaging technology. The project partners will develop three different demonstrator that will be tested during the third year of the project:

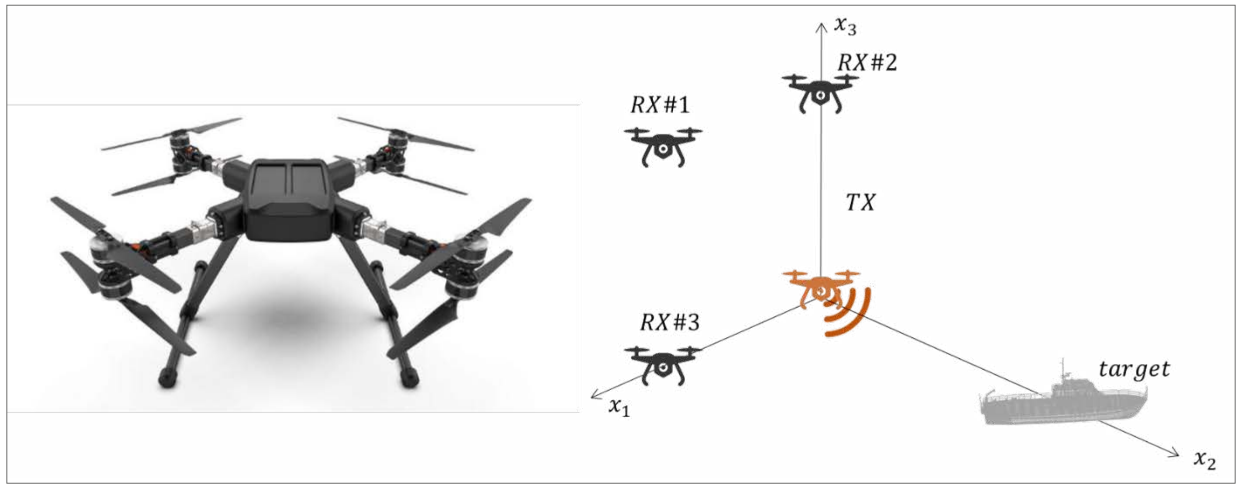
- A ground based interferometric radar system
- A Ship borne interferometric radar system
- A drone based interferometric radar system using 4 drones flying in formation.

Technical Sheet
Funding institution:
MoD (IT)
Project partners
GEM, ECHOES, WUT, PIT-RADWAR
Project duration
January 2020 - October 2023
Involved countries
Italy, Poland

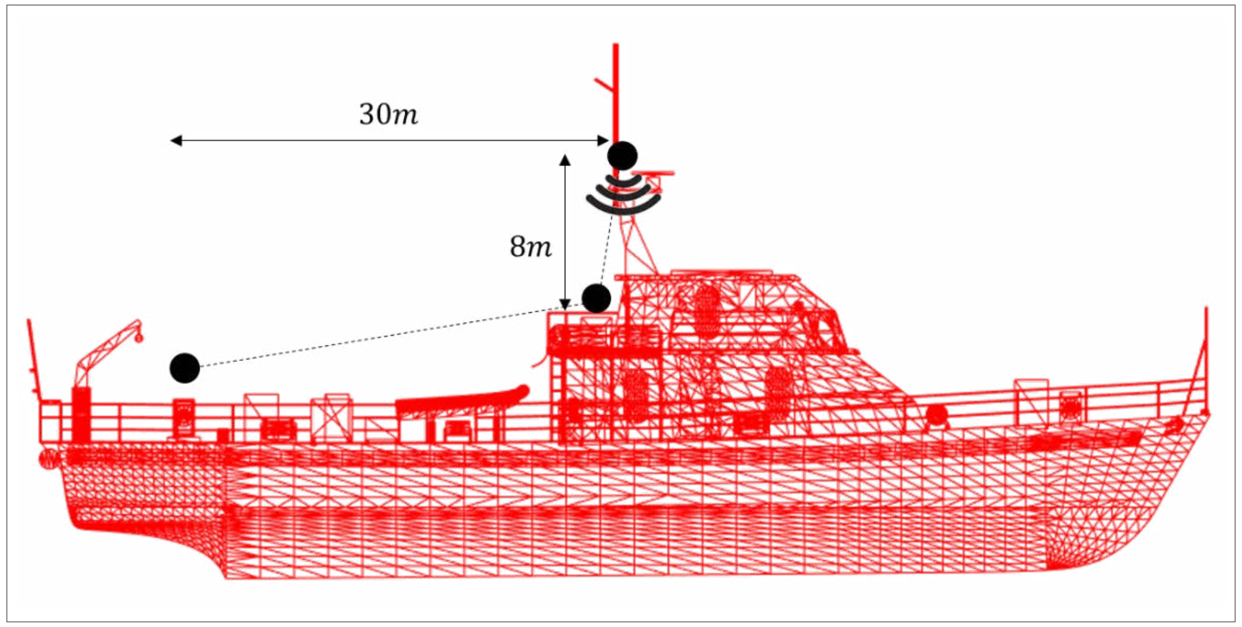
(a)The first ground based interferometric radar system developed at the RaSS laboratory in 2016 - PIRAD demonstrator



(b) An example of 3D InISAR results using real data acquired using PIRAD system. the results of the 3D InISAR is a cloud of point in the 3D space and is compared in this figure with the target CAD model



(c) Drone selected for the drone-based demonstrator (left). The overall system will be composed of 4 drones, one equipped with a radar transmitter and the others equipped with radar receivers;



(d) A pictorial illustration of a possible installation on board of a ship. In this case three antennas can be used if synchronised both in frequency and phase. One antenna transmits while the others receive. An example of possible antenna distances is provided with the aim to show realistic values that could be used to enable 3D interferometric ISAR

PROJECT SAFE-LAB

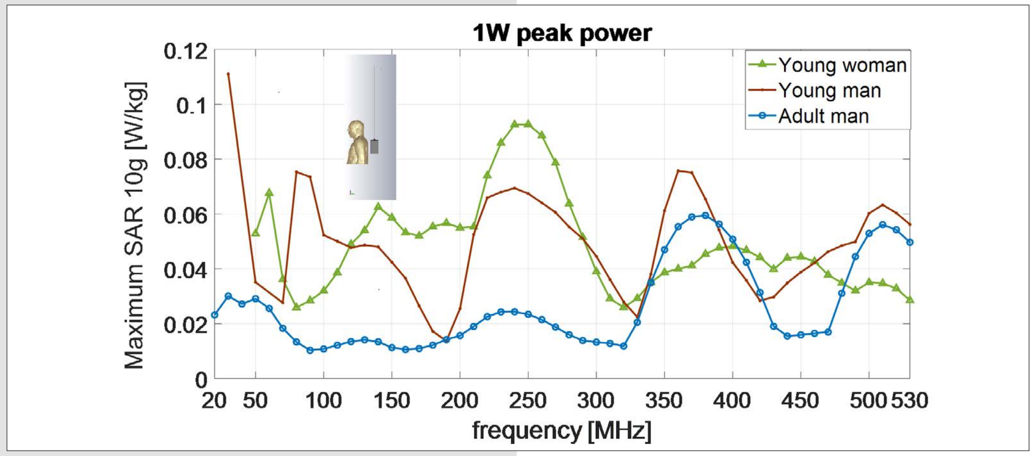
Laboratory for the Evaluation of the Safety of Portable Intentional Electromagnetic Sources

The potential effects of radio frequency (RF) electromagnetic fields (EMF) on human body are currently not sufficiently known and results presented in literature are often conflicting each other. The continuous development of new technologies and the increasing diffusion of several transmitting devices simultaneously operating on different frequencies and in proximity of the operators poses a safety problem on exposure to electromagnetic fields both in civil and military world. Instruments/capabilities, able to guarantee an increasingly complete and correct assessment of the exposure scenario are becoming a priority. The guidelines on workers exposure at the EMF are based on civilian applications and they are therefore not suitable for signals typically used in the military scenario. Since civil research is not focused on specific signals used in military applications, the SAFE-LAB Project specifically aims to accurately investigate the levels of EMF exposure and the Specific Absorption Rate (Specific Absorption Rate - SAR), using representative schemes of systems and radio protection commonly implemented in operational scenarios. The results of the study will lead to:

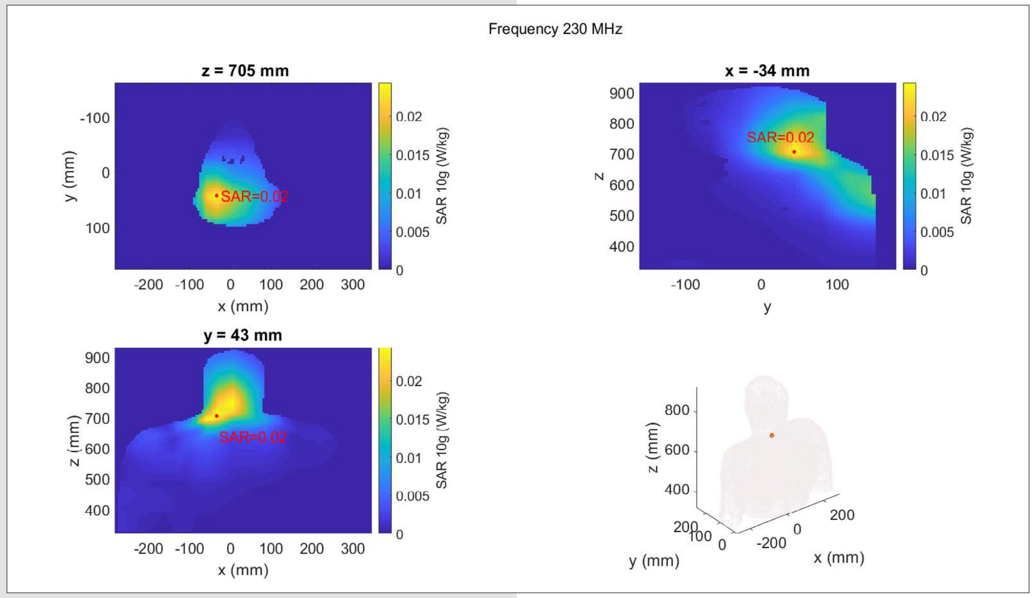
- guidelines definition for use of portable systems;
- proposing innovative solutions for shielding the operators;
- proposing technical solutions on minimizing systems exposure, by maintaining operational efficiency;
- carrying out a test set for measurement and qualification of all the portable devices used in military applications.

Safelab

Technical Sheet
Funding institution:
MoD (IT)
Project partners
Project partners *University of Pisa, Free-Space SRL*
Project duration
February 2020 - September 2021
Involved countries
Italy



(a) Specific Absorption Rate numerical estimation according to the frequency for three different numerical human models



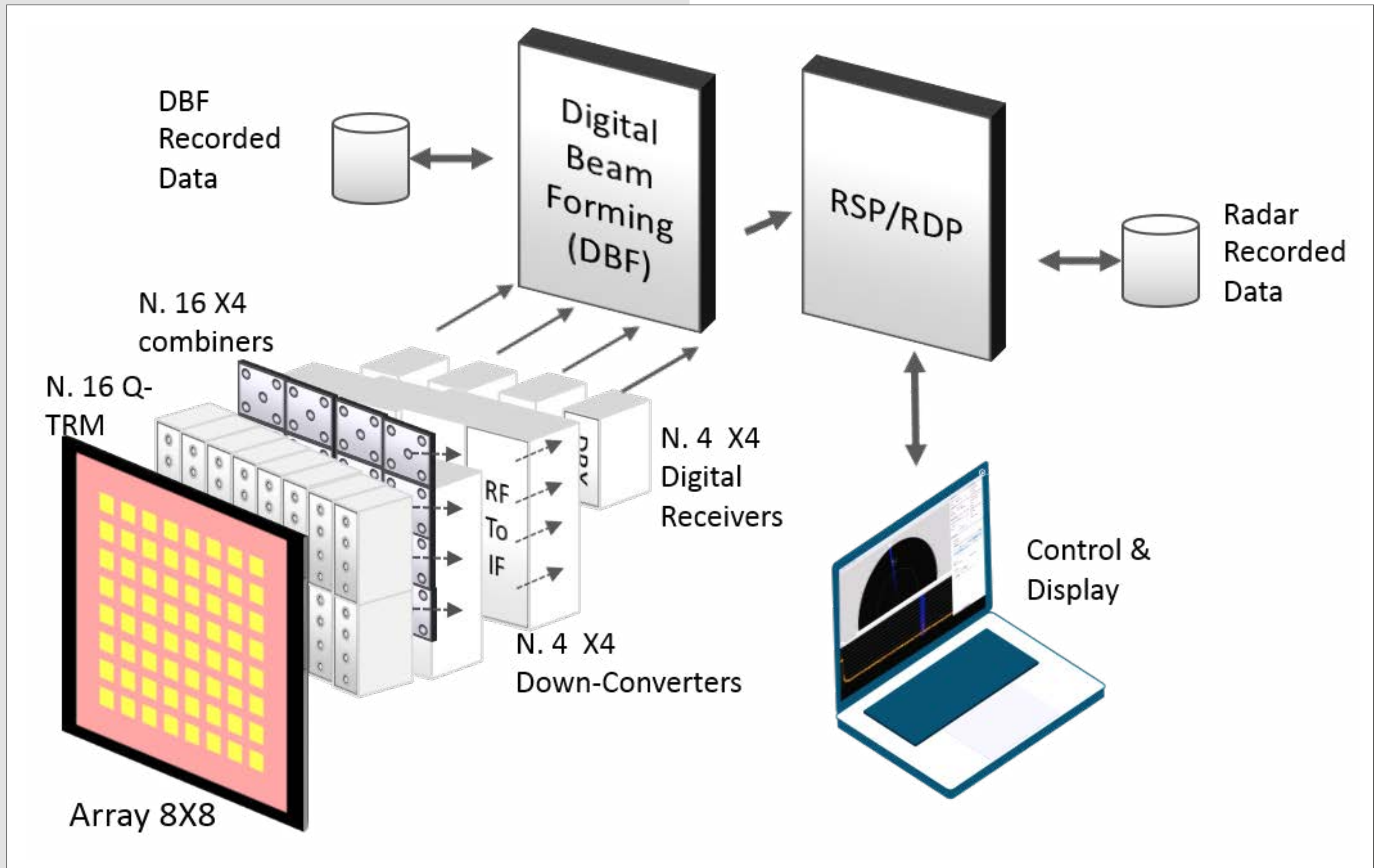
(b) Specific Absorption Rate numerically obtained at 230MHz for protocol and setup definition

PROJECT SAMBA-X

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

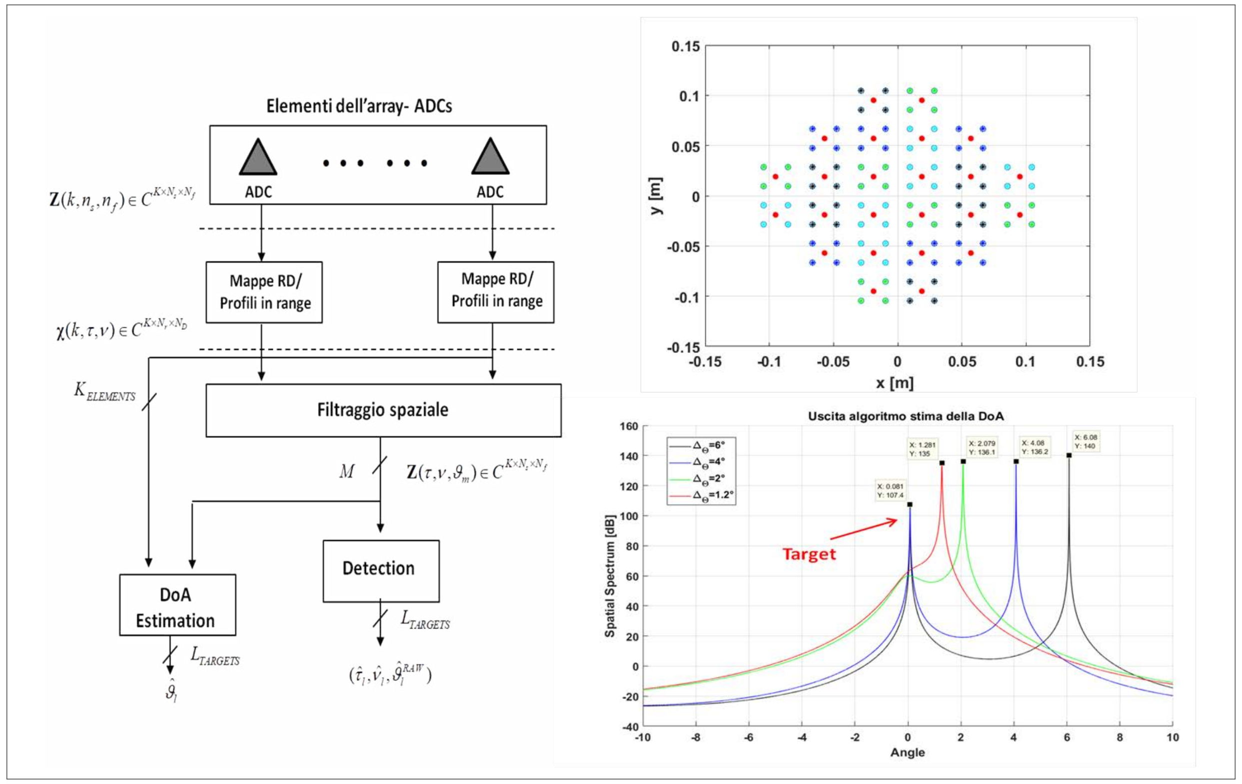
Traditional seekers use a mechanical scanning antenna, which limits the overall system performance. With the improvement of the latest microwave device technologies, Active Electronic Scanned Array (AESA) has become implementable in seekers. This allows for substantial performance improvements, which 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 Failure (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.

Technical Sheet
Funding institution:
Italian MoD
Project partners
ELDES s.r.l
Project duration
February 2020 - February 2022
Involved countries
Italy

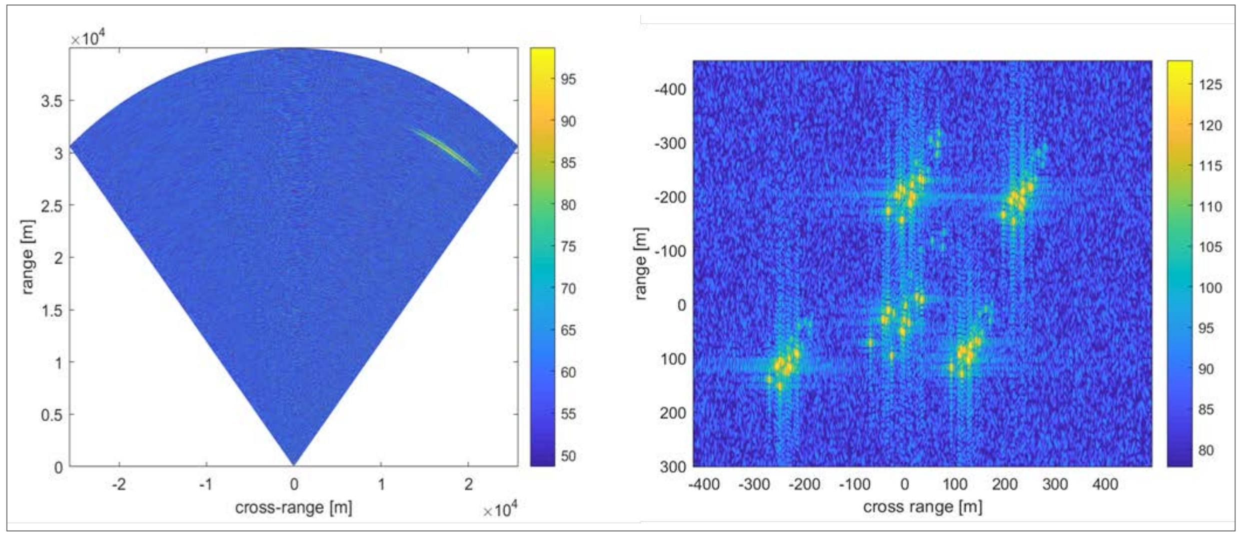


(a) Demonstration Diagram (ELDES s.r.l)

(b) Demonstration Layout (ELDES s.r.l)



(c) Preliminary DBF architecture and results obtained by applying DBF on AESA antenna divided into sub-arrays



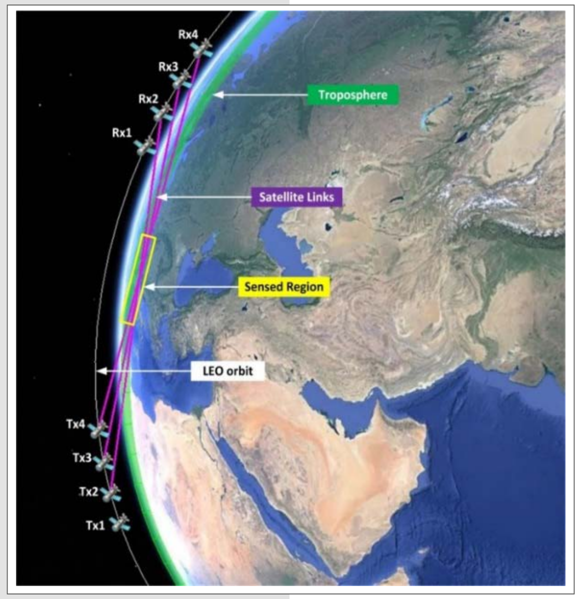
(d) Preliminary results on the radar imaging technique application

PROJECT SATCROSS

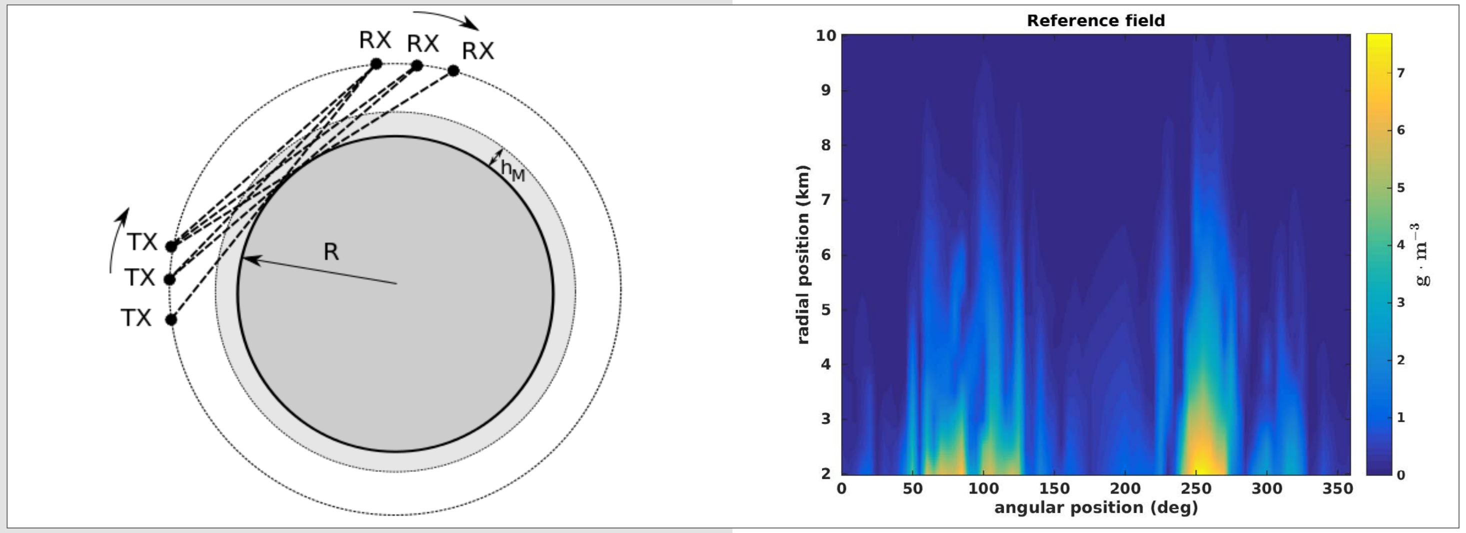
Satelliti CoROtanti per la Stima di vapor acqueo in tropoSfera

The CNIT researchers involved in the SATCROSS project have recently devised a method called NDSA (Normalized Differential Spectral Attenuation), which is useful for obtaining the integrated water vapor (IWV; Integrated Water Vapor) from a pair of attenuation measurements carried out in the microwave frequency range. In particular, NDSA has been shown to effectively estimate the IWV along the path between two Low Earth Orbit (LEO) satellites - one carrying a transmitter and the other a receiver - in a limb measurement geometry, using frequencies of transmission in the Ku and K frequency bands (and even higher in the case of the higher tropospheric layers). The NDSA method is based on measuring a parameter called “spectral sensitivity” which is the normalized incremental ratio of the spectral attenuation and was found to be linearly related to the IWV along the path between the two LEO satellites. The SATCROSS project aims at providing a pre-feasibility study for a space remote sensing system based on a train of LEO satellites orbiting in the same plane and along the same direction (configuration of co-rotating satellites). In such a configuration, in which one or more LEO satellites with an on-board transmitter follow(s) one or more LEO satellites with a receiving apparatus, the NDSA measurements (and consequently the resulting IWV estimates) refer to links that cross the troposphere at certain altitudes predetermined by the Earth, connections that in this way “brush” an entire annular region in the orbital plane. It is thus possible to estimate the two-dimensional field of water vapor in the aforementioned annular region starting from the entire set of IWV measurements based on an inverse problem formulation. Such a remote sensing system will be able to recover two-dimensional water vapor fields on vertical sections of the troposphere on a continuous time basis.

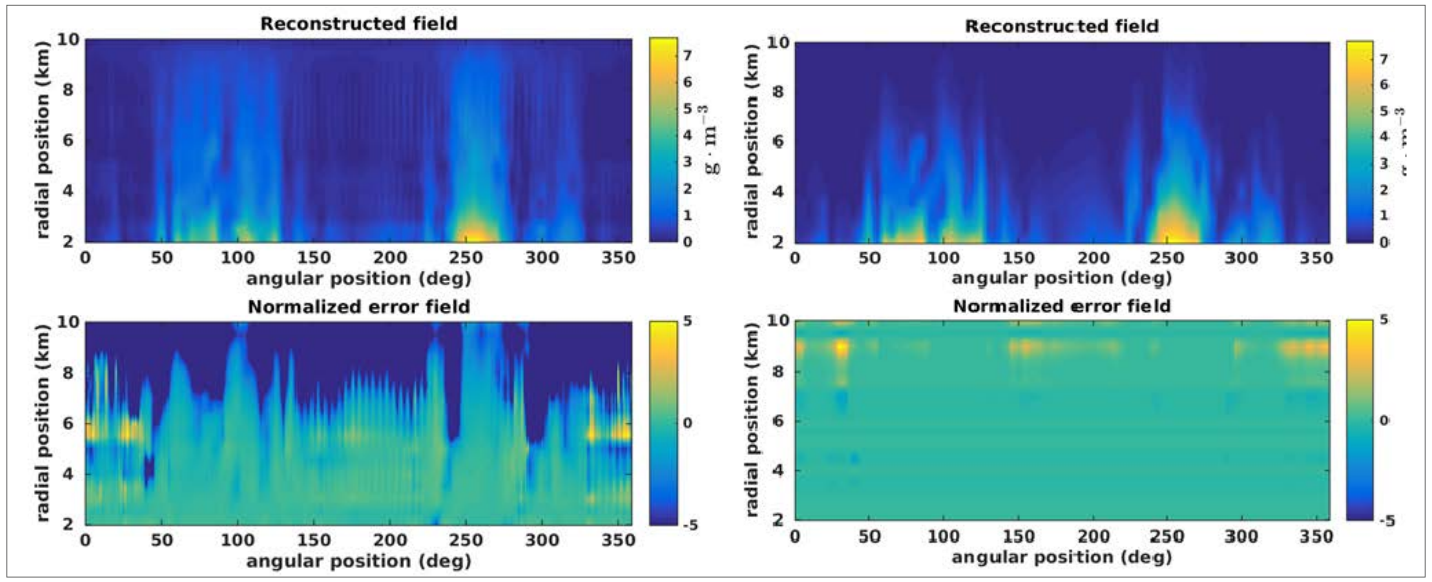
Technical Sheet
Funding institution:
ASI
Project partners
Lamma, Picosats s.r.l.
Project duration
March 2020 - March 2022
Involved countries
Italy



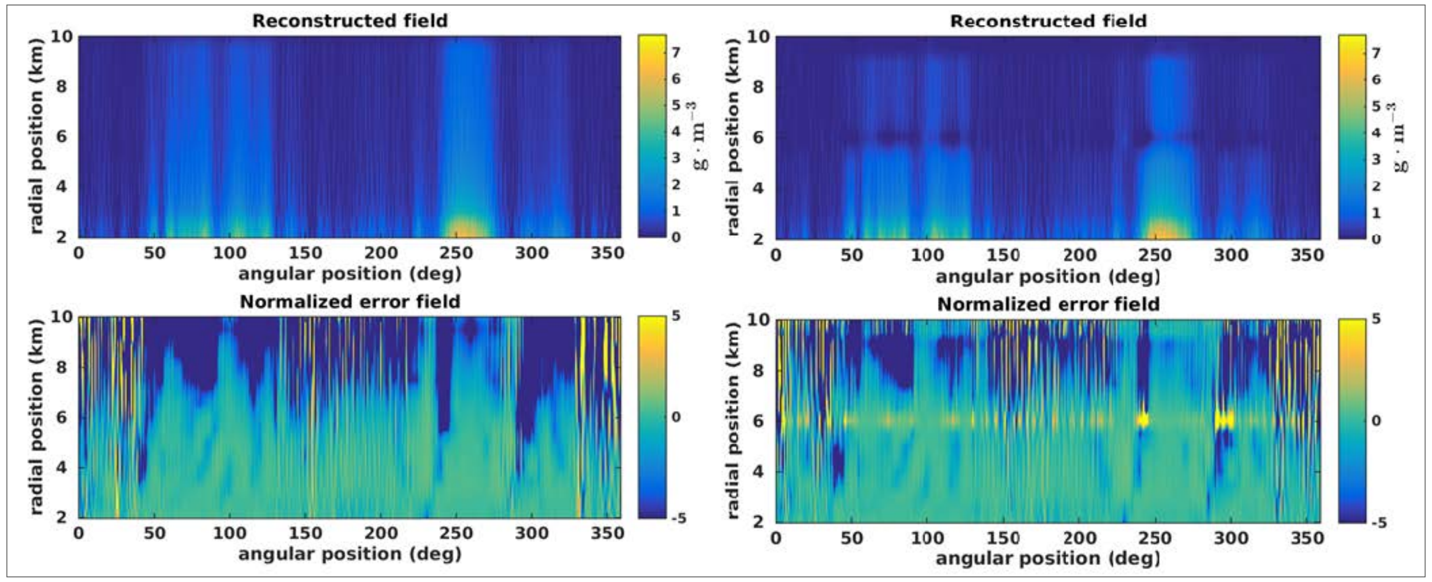
(a) Measurement configuration scheme



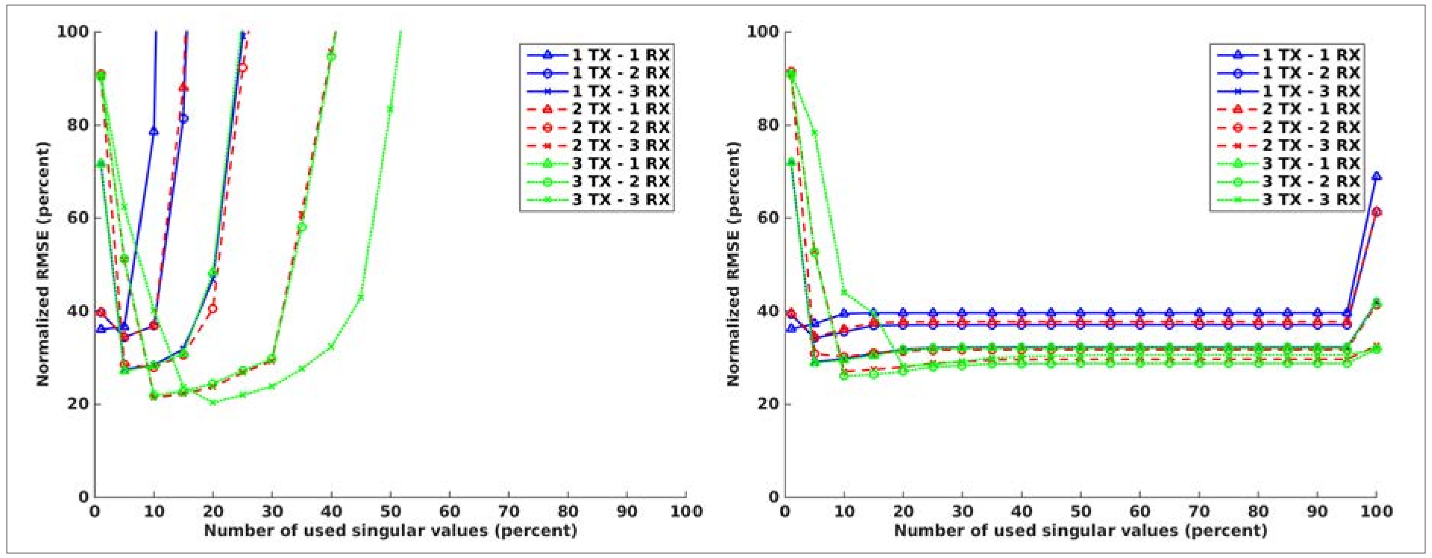
(b) Reference (truth) WV field



(c) Reconstructed WV fields and error fields using LLS (linear Least Squares) inversion in the ideal case (no signal impairment) and an integration time for spectral sensitivity measurements T=1 s and only 30% of the singular values of the inversion matrix. Left panels: results for 1 link (1Tx-1Rx); right panels: Left panels: results for 3 links (1Tx-3Rx)



(d) Reconstructed WV fields and error fields using Tikhonov regularization (linear Least Squares) inversion, accounting also for signal impairments, for an integration time for spectral sensitivity measurements T=1 s and only 30% of the singular values of the inversion matrix. Left panels: results for 1 link (1Tx-1Rx); right panels: Left panels: results for 3 links (1Tx-3Rx)



(e) Normalized root mean square of the reconstruction error versus number of singular values of the inversion matrix used for retrieving the original WV field, for T=1 s and accounting for different Tx-Rx configurations. Left panel: LLS case; right panel: Tikhovov regularizationgram (ELDES s.r.l)

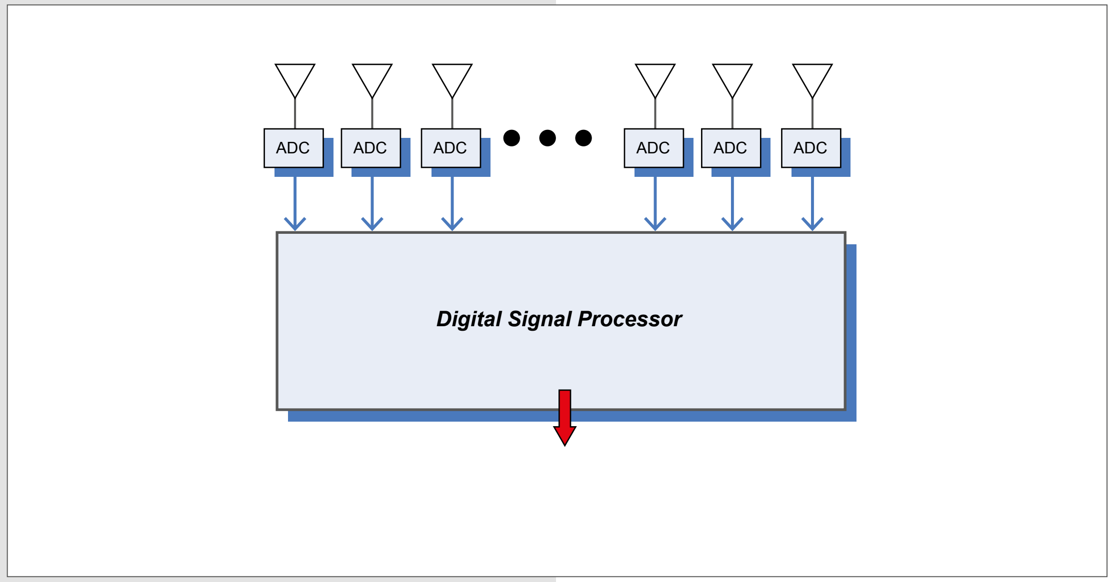
The objectives of this project are:

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.

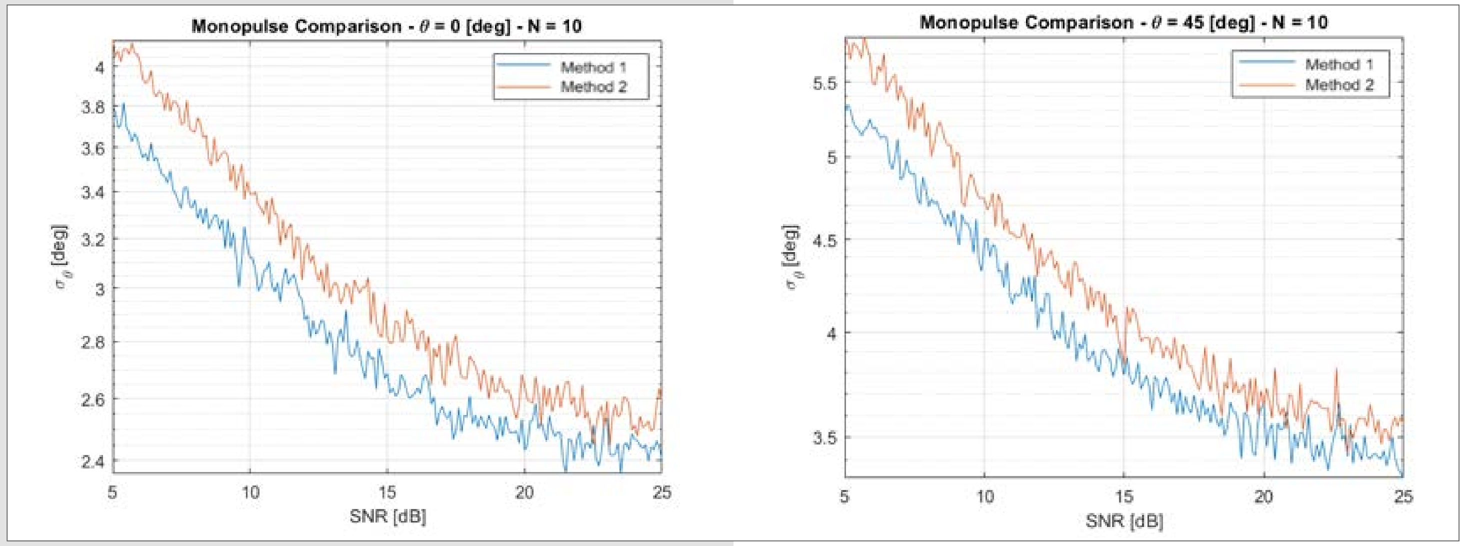
The proposed architecture will have characteristics of scalability, flexibility and adaptability that will allow future multifunction radar systems that will be based on it to:

- 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).

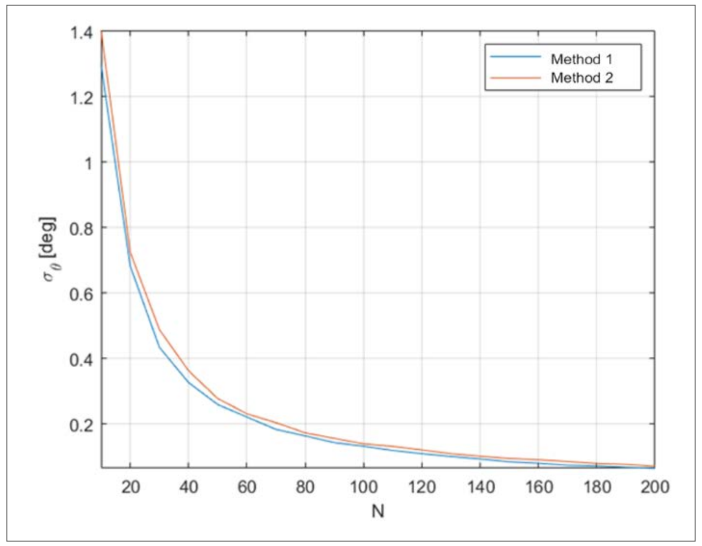
Technical Sheet
Funding institution:
Italian MoD
Project partners
Leonardo spa, Echoes srl
Project duration
April 2020 - April 2023
Involved countries
Italy



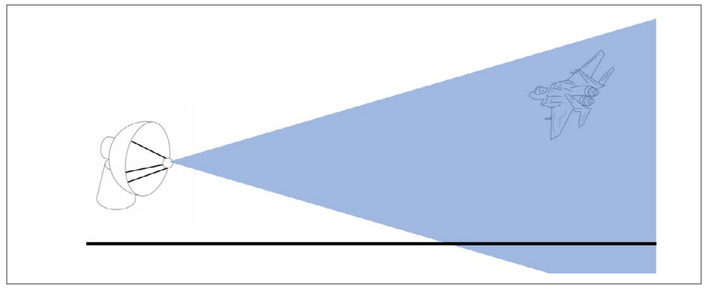
(a) Digital Array Radar Architecture



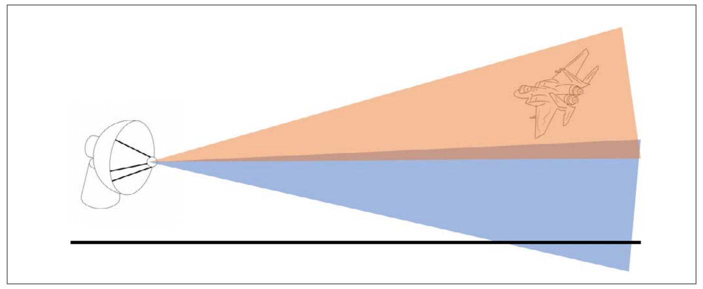
(b) Results using conventional and alternative monopulse for different directions of arrival (☐=0°, 45°) with N (number of elements) equal to 10



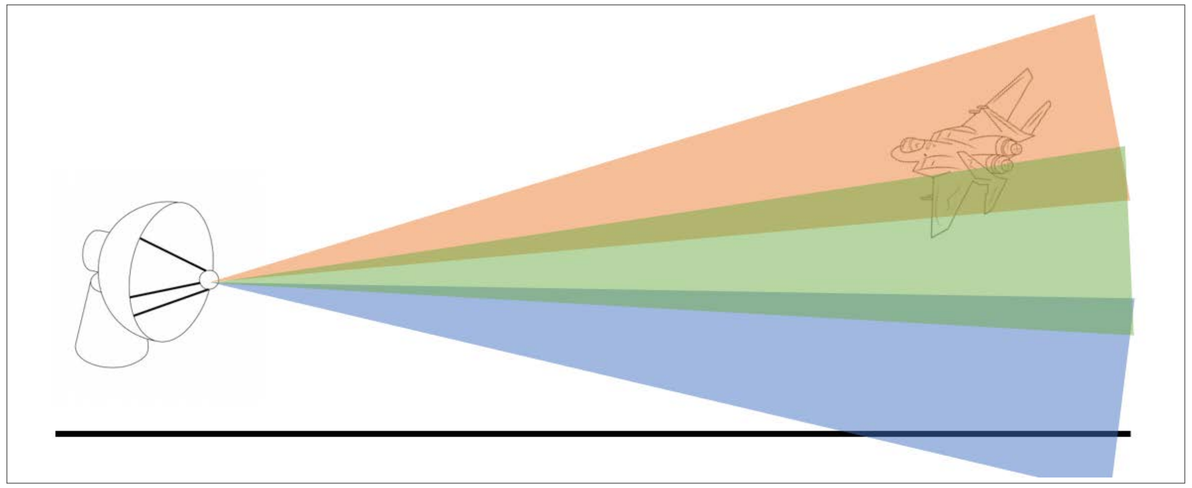
(c) Standard deviation of the error in degrees on the direction of arrival



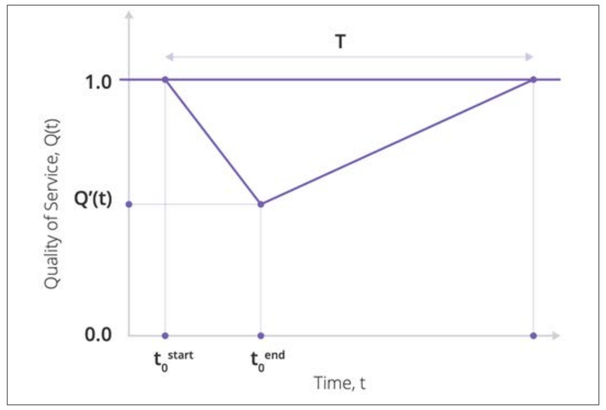
(d) Simulated single fan-beam geometries



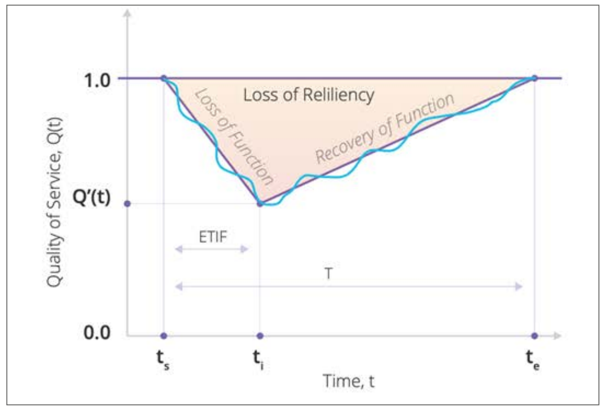
(e) Simulated double fan-beam geometries



(f) Simulated multiple fan-beam geometries



(g) Zobel model cyber resilience



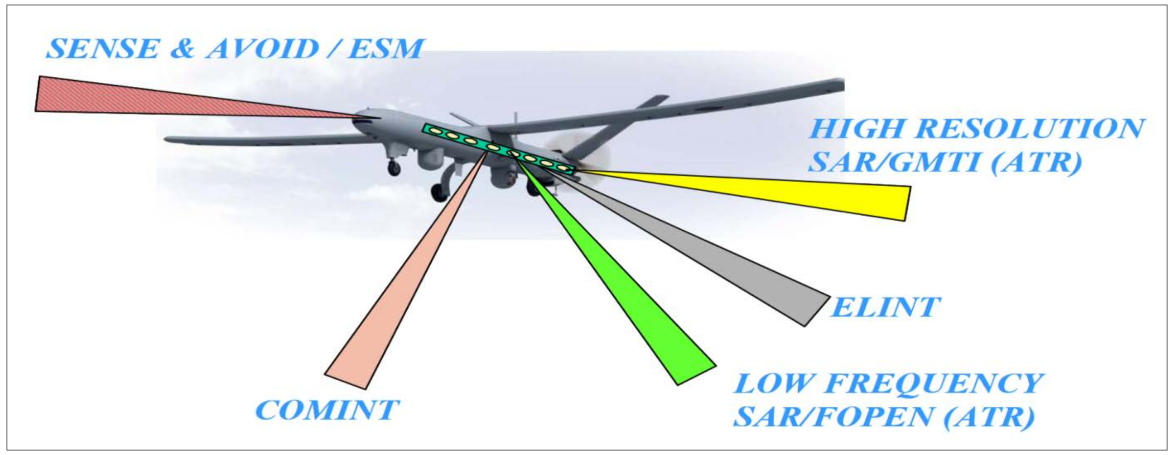
(h) Reference model cyber resilience

The scalable multifunction RF (SMRF) concept has been launched nearly 20 years ago by the EU defense community and several papers have been written on that topic. To some extent, it is referring to all-in-one RF system or system of system concepts, with operational mission environment dependent functions, i.e. having the capability to optimize on the fly radar, communication and electronic warfare functions.
Such an ability relies on sub-systems already available having high level of versatility such as wideband reconfigurable active phased array antennas, high speed DAC/ADC, System on Chip (SoC), arbitrary waveform generators (AWG), combined with RF mode management procedures based on cognitive techniques using for instance artificial intelligence techniques to learn and evolve. As an example, and based on this approach, USAF claimed to give F-35 Joint Strike Fighter an almost-living ability to sniff out new hard-to-detect air defenses and invent ways to foil them on the fly.
Therefore, it becomes obvious that this concept, besides addressing SWAP-C challenges, should be a real breakthrough to cope with increasing complexity of operational environments. However, and beside the fact that several studies supported by EDA are coping with that system concept, very few approaches for specification, test and validation of such systems have been reported. Indeed, and for example, measuring the knowledge level of a system or its ability to adapt its configuration to various environments along a mission, remain largely to invent. Hence, defining those approaches will be the aim of the study and this should support the Radar Captech TBB09 addressing "Common EU Benchmarks for Validation, Verification and Standardisation".

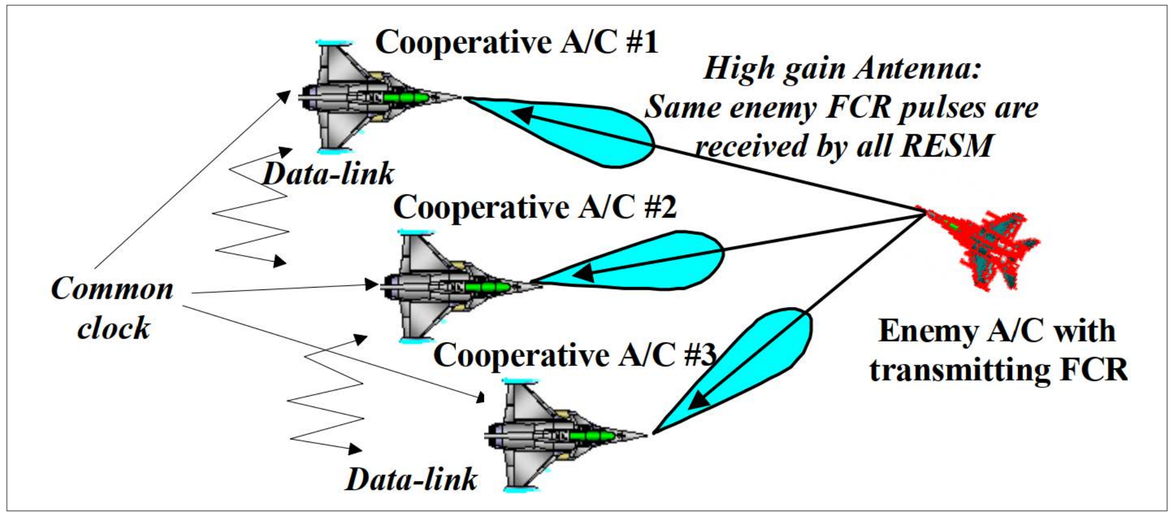
Technical Sheet
Funding institution:
EDA
Project partners
ONERA, HENSOLDT, Fraunhofer FHR
Project duration
October 2019 - October 2020
Involved countries
Italy, France, Germany

Radar Techniques	E-Beam Steering	Multi-Channel\STAP	(Ultra) HR SAR	HR (Wide) Swath SAR	Interf. SAR Along Track	Interf SAR Cross Track	(Coherent) Change Detect.	Spot SAR	ISAR	Polarisation Agile SAR	Foliage Penetration	Dual Band Radar
Air-to-Surface Surveil-lance Applications												
Civilian												
Environmental Observation				X						X		X
Vegetation Classification				X			X			X		x
Agriculture Monitoring				X			X			X		
Iceberg Detection				X								
Disaster Monitoring	D	X	X				X	X				
Oil Spill Detection	D	D		X						X		
Cartography (3D)				X		X						
Search and Rescue	X	D		X					X			
Defence and Security												
IED Detection			X				X	X				
Situational Awareness	X	X	X	X				X			X	
Battle Damage Assessment			X					X				
Precision Target Location	D	D	X				X					
Classification/Identification			X					X	X	X		
Hidden Target Detection								X		X	X	X
Maritime Piracy	X	X						X	X			

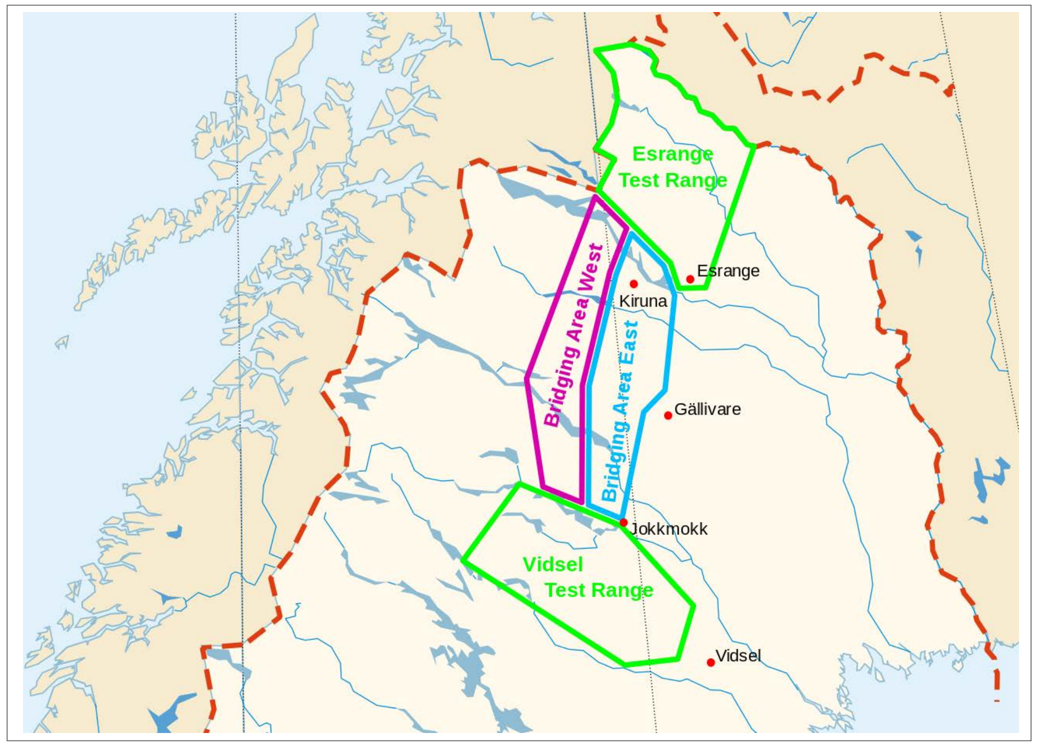
(a) Functions of a SMRF system and possible applications



(b) SMRF concept for airborne platforms



(c) Cooperative multiplatform DOA with high antenna gain



(d) Vidsel test range for defence application (Sweden)

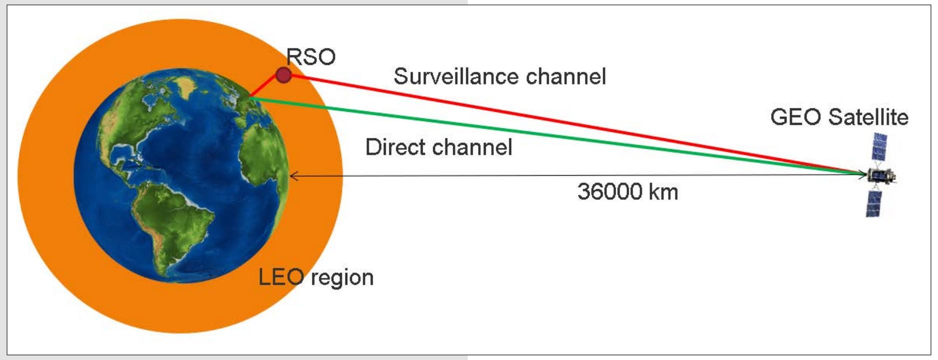
Sistema Radar Passivo per la rivelazione di oggetti in orbita terrestre bassa - Passive radar system for the detection of low-Earth orbit objects

The proposed technological solution is focused on the use of a passive radar based on an array antenna that uses signals transmitted from satellite platforms (e.g.: DVB-S/DVB-S2) as illuminators of opportunity. This approach represents an opportunity of particular interest for the detection of space debris, thanks to the very wide coverage that transmitters in geostationary orbit can guarantee. The passive radar architecture allows for continuous surveillance (24 hours on 7 days), without the use of any own transmitters, minimizing costs and energy consumption. In order to improve the radar detection performance, we propose the adoption of an array antenna formed by a high number of receive-only elements, therefore limiting the realization costs. Moreover, a single receiving element will be equipped with a flexible reception system capable of digitizing high-bandwidth signals. The ability to acquire broadband signals will allow the system to exploit a large part of the energy radiated by the satellite in order to improve the level of SNR. The use of an array of antennas and digital beamforming techniques can enable the achievement of a sufficient gain and the possibility to scan electronically the volume under surveillance.

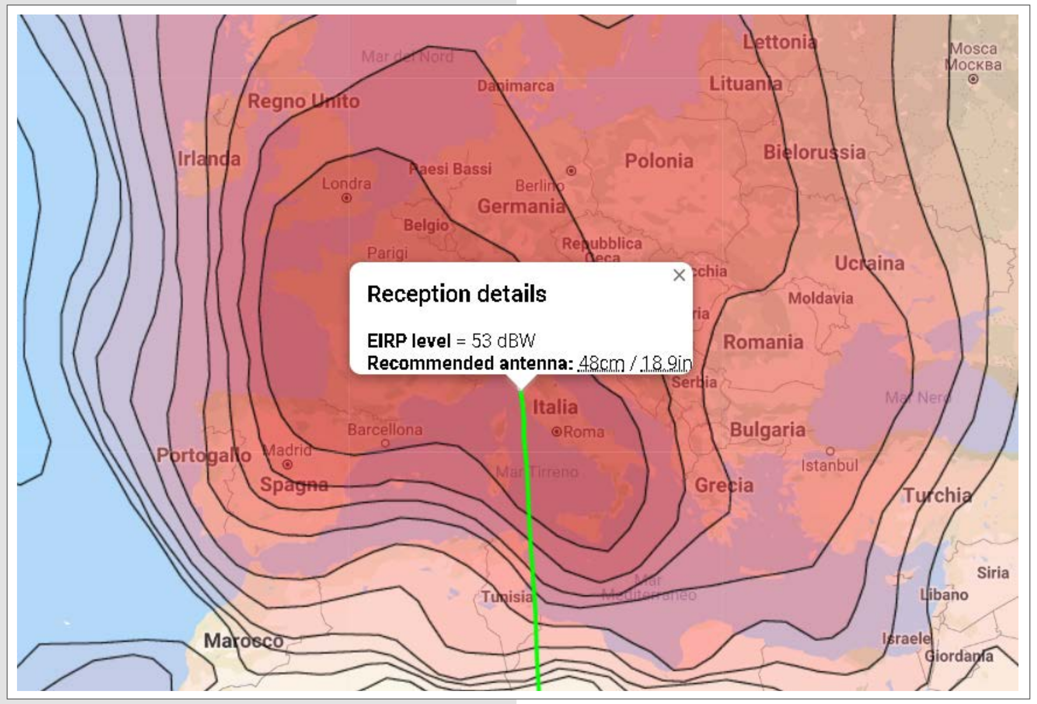
The main objectives of the Phase 1 (first year) of the project are:

- Definition of system requirements;
- Study and definition of the receiver antenna array geometry configuration;
- Study and definition of digital beamforming techniques;
- Study and definition of the signal processing system.

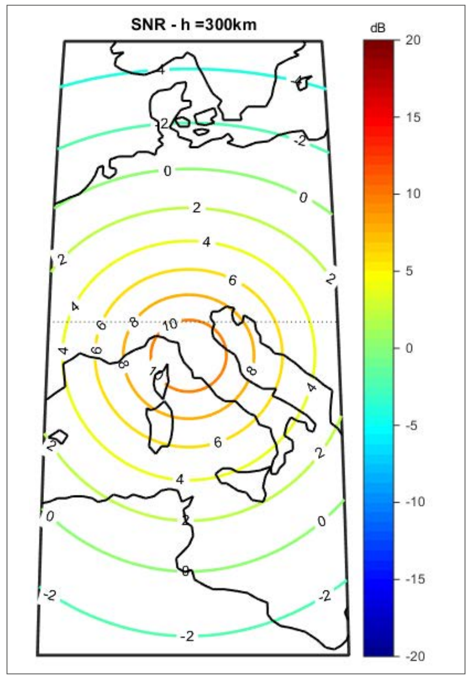
Technical Sheet
Funding institution:
Italian MoD
Project partners
ECHOES S.r.l.
Project duration
February 2020 - November 2020
Involved countries
Italy



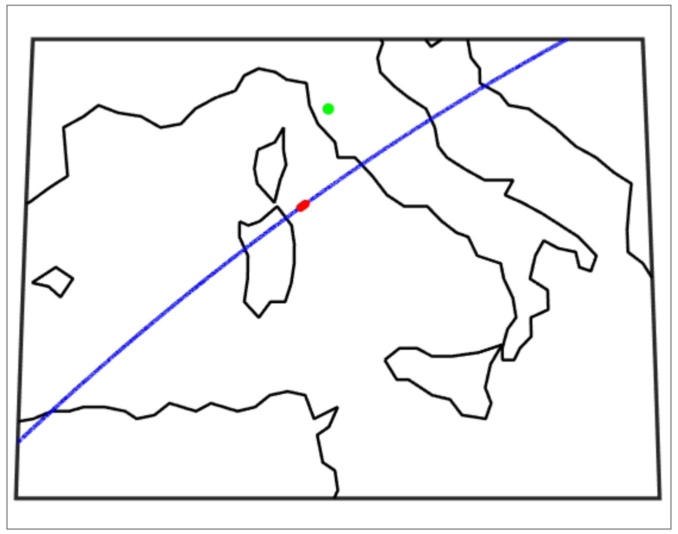
(a) Geometry of a satellite-based passive bistatic radar



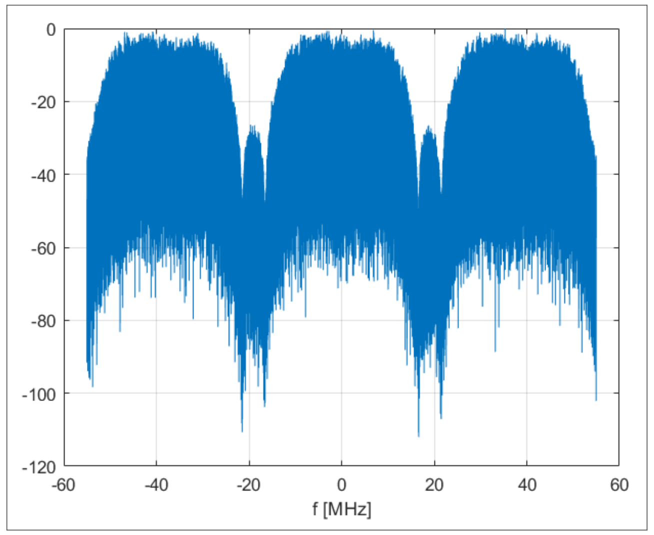
(b) Eutelsat Hotbird 13C footprint



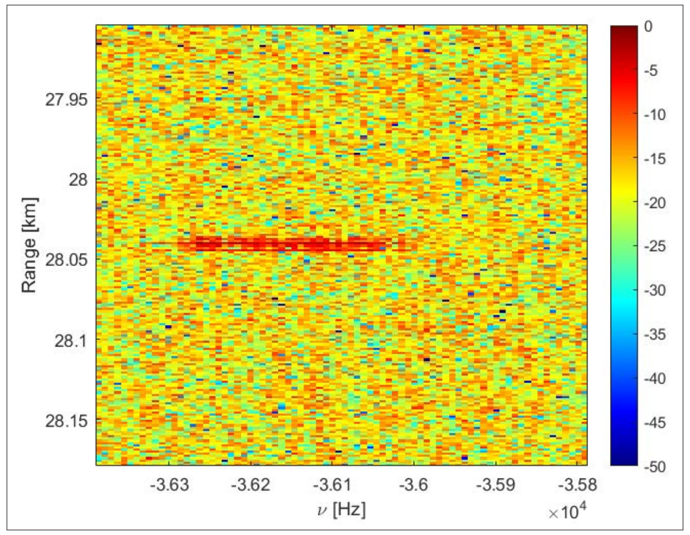
(c) Expected SNR map obtained for a target with RCS=20 dBsm at an height=300 km



(d) International Space Station recorded data of a pass over Italy used for simulation purposes (30/10/2019 – UTC 03:10:00)



(e) Three channel DVB-S2 simulated signal spectrum



(f) Simulated range Doppler map (3 channel DVB/S2) related to the ISS pass over Italy

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CERTIFICATION

From 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 3).

DNV·GL

MANAGEMENT SYSTEM CERTIFICATE

Certificate No:	Initial certification date:	Valid:
211274-2016-AQ-ITA-ACCREDIA	19 January 2017	20 January 2020 - 19 January 2023

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 - 56024 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), 07 January 2020

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

SGQ N° 003 A
SGA N° 003 D
SGE N° 007 M
SCR N° 004 F
EMAS N° 009 P
PRD N° 003 B
PRS N° 094 C
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 GL - Business Assurance
Via Energy Park, 14, - 20871 Vimercate (MB) - Italy

Zeno Beltrami
Management Representative

Lack of fulfilment of conditions as set out in the Certification Agreement may render this Certificate invalid.
ACCREDITED UNIT: DNV GL Business Assurance Italia S.r.l., Via Energy Park, 14 - 20871 Vimercate (MB) - Italy. TEL:+39 68 99 905. www.dnvgl.it

Figure 3 - Lab RaSS ISO 9001/2015 DNV certificate.

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