



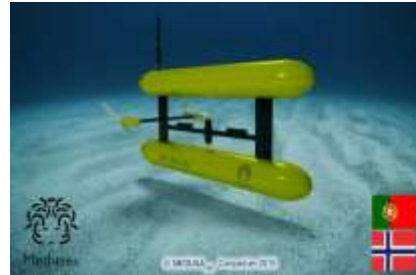
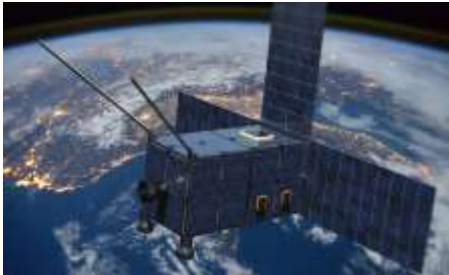
LARSyS

Laboratory of Robotics
and Engineering Systems

FCT

Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Technologies for Ocean and Space Exploration & Exploitation





LARSyS – Laboratory of Robotics and Engineering Systems

One research organization with 4 R&D units

- Institute for Systems and Robotics (ISR-Lisboa)
- Centre for Innovation, Technology and Policy Research (IN+)
- Marine, Environment & Technology (MARETEC)
- Madeira Interactive Technologies Institute (M-ITI)

Facts & Numbers:

- 187 PhDs
- 140 PhD students
- 450+ Researchers

OCEANS - Exploration **URBAN - Sustainability**



AIR - Space



LIFE - Engineering



INTERACTION - Cognitive





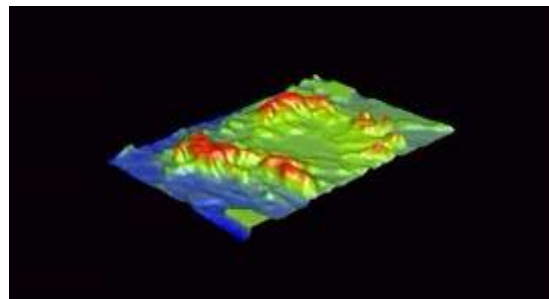
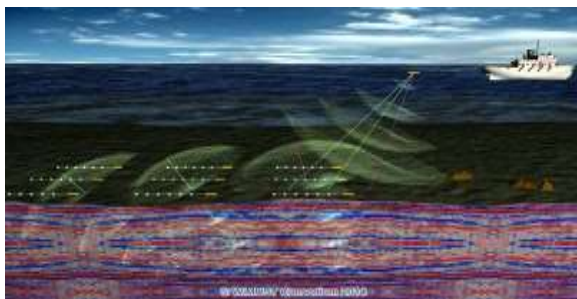
LARSyS

Laboratory of Robotics
and Engineering Systems

FCT

Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Technologies for AIR-Space Exploration & Exploitation





AIR - Space

- Research on specific technologies for space and aeronautics;
- Research on innovation processes on technology adoption;
- Highly linked to a large group of end users/industrial partners.
- Covers propulsion, machine interaction, guidance navigation and control, (GNC), cockpit design and innovation for aerospace applications.

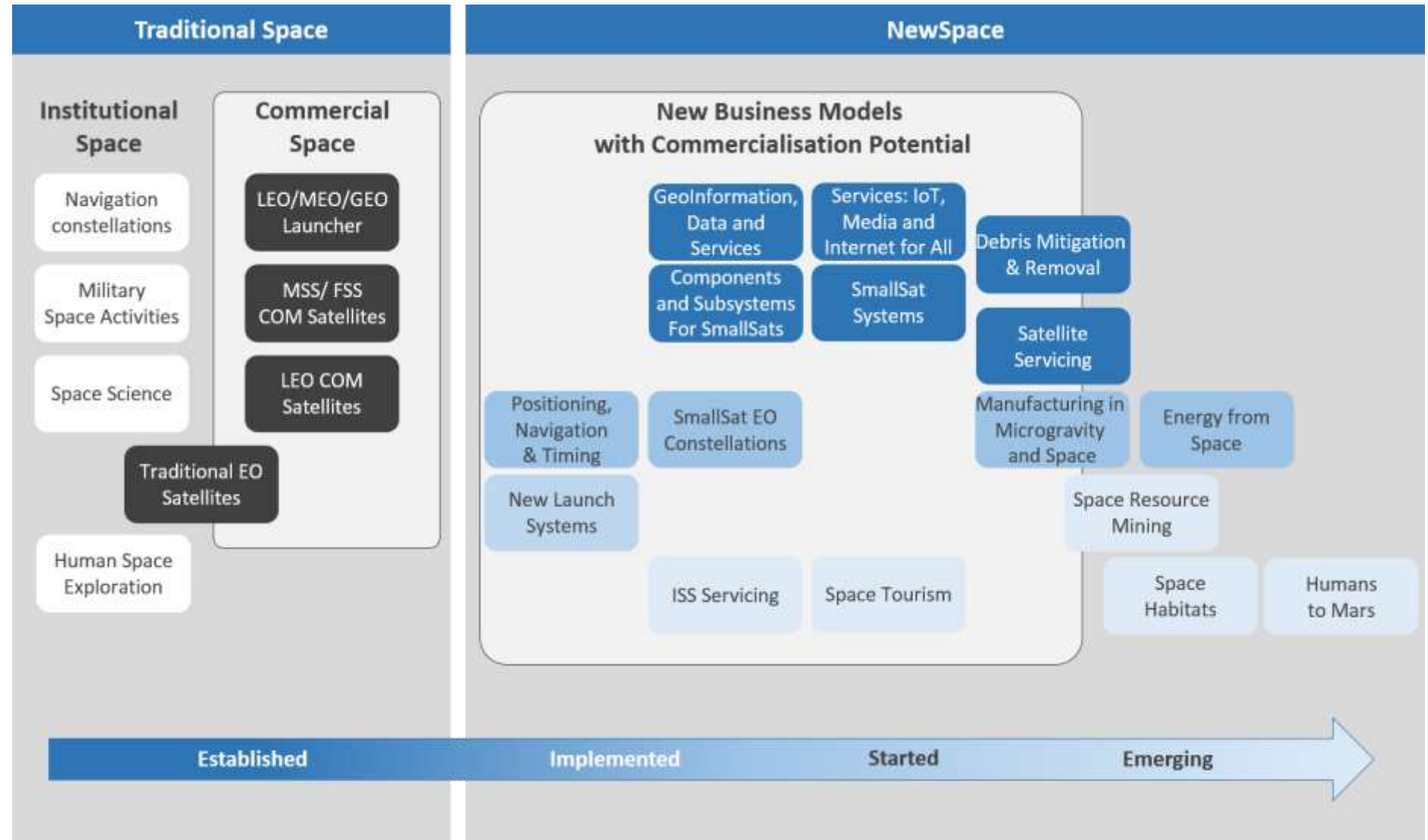


AIR - Space

- Participation in the INFANTE project the first national micro-satellite
- Collaboration w/ NASA, space co-bot
- Work on Drones (H2020 Multidrone and P2020 ELEVAR)
- Involvement in the Aeronautics and Space cluster for innovation policies



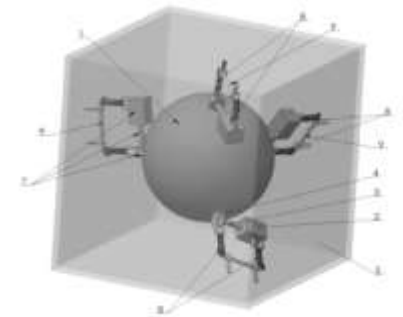
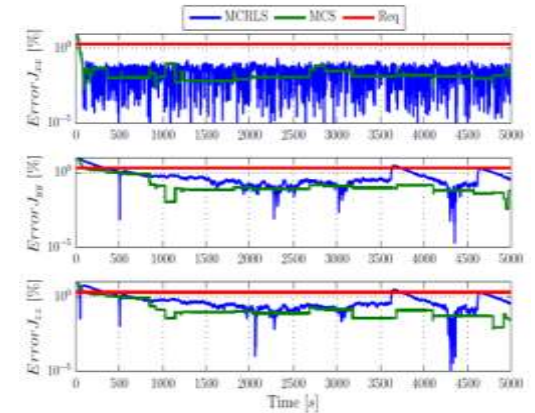
New Space



Space Robotics & Technologies

Topics:

- Attitude estimation and control
- Inertial parameters estimation
- Human-robot interaction
- Mobile manipulation
- Estimation and detection from satellite data
- Formation state estimation and control



Space Robotics & Technologies

Applications:

- Micro-satellite constellation for observation and communication
- Distributed IMUs for Internet of Things
- Collaborative robots in microgravity



INFANTE (P2020)



VIENA (internal)
8

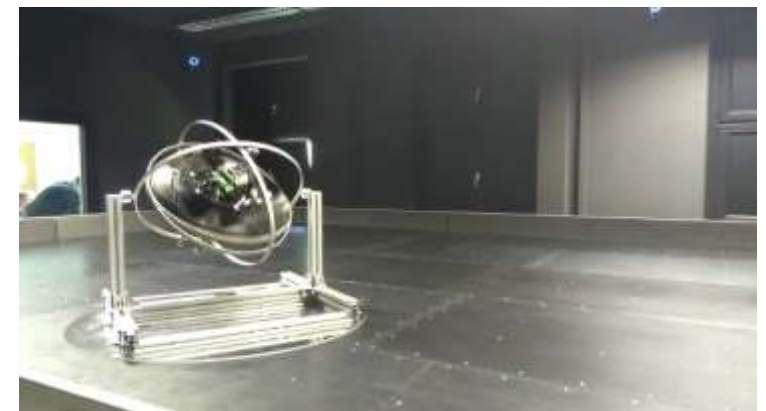


Space CoBot (internal)

Space Robotics & Technologies

Field trials:

- Test sessions on the International Space Station (ISS) using the SPHERES robots for formation control tests (MIT-Portugal seedling project ReSwarm)
- Test campaign of Space CoBot at the TU Braunschweig's air-bearing table





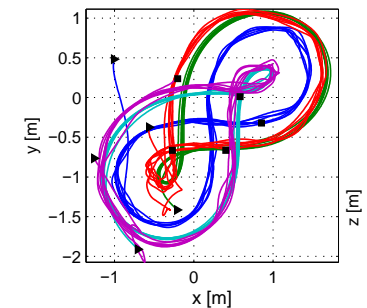
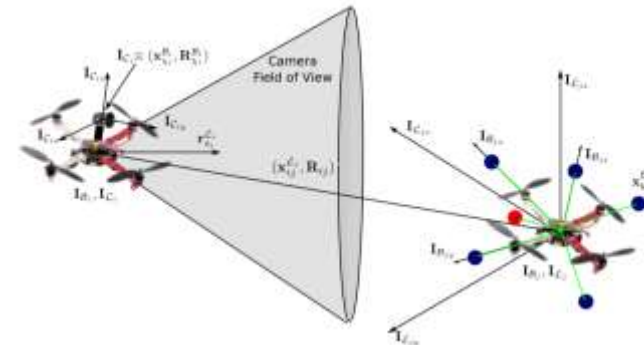
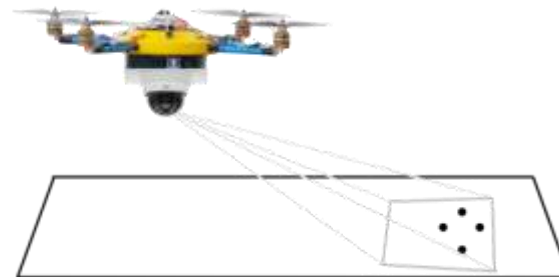
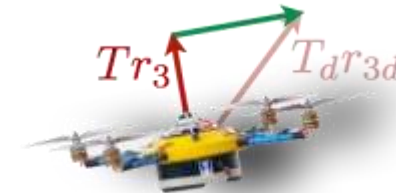
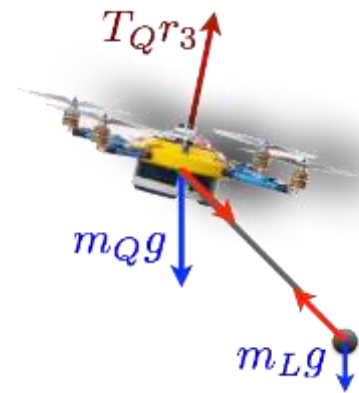
Aerial Robotics

Motion Control

- Aggressive Maneuvers
- Multi-vehicle Formation Control
- Load Transportation

Airborne Sensing

- Vision
- Acoustics
- LiDAR



15+ journal publications

Aerial Robotics - Applications

5 ongoing projects + 3 approved

- Fire prevention and firefighting assistance
- Air-Sea Surveillance
- Infrastructure Inspection
- Aerial Cinematography

 **SEAGULL**



ELEVAR



 **PORTUGAL 2020**



Remote sensing for pasture optimization

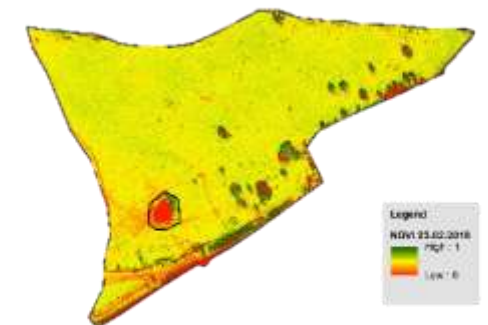
Data acquisition from:

Pasture monitoring and conventional sampling/analysis

- Plant yield, fraction of legumes, chemical analysis
- Soil characteristics (organic matter, nitrogen and phosphorus availability, etc.)

Remote sources of data

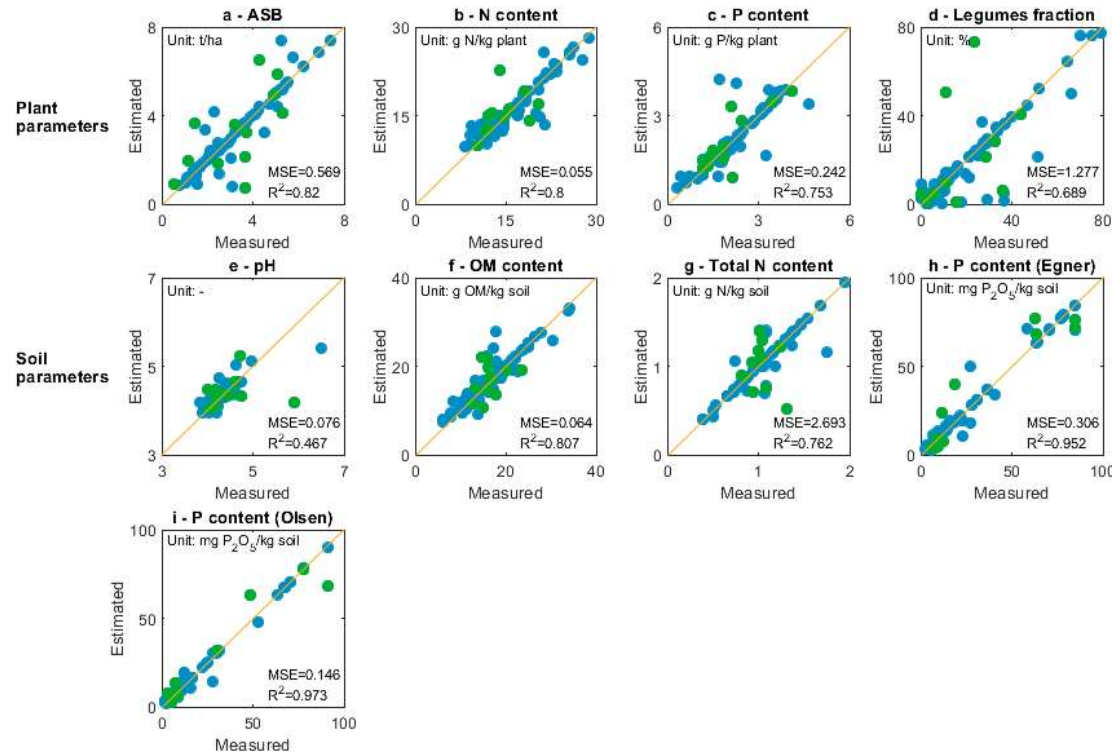
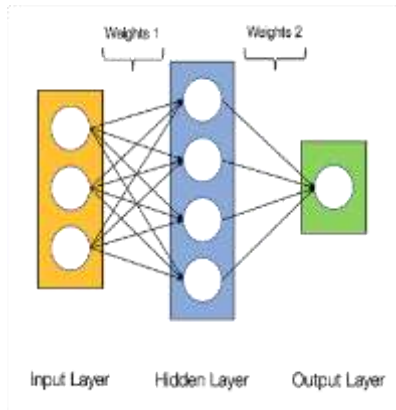
- Satellite (Sentinel 2)
- Drone flights



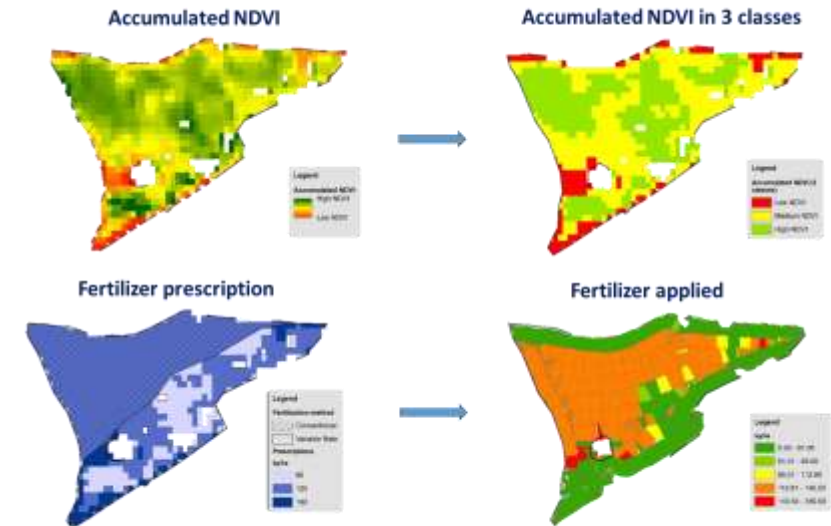


Applications for pasture farming

Modelling and estimation of plant/soil variables using remote sensing



Production of detailed fertilizer prescription maps



Current work & Future Work

Facilitate mobile **robots' teleoperation** (current focus on Unmanned Ground Vehicles) exploring:

- haptic devices aiming at reducing operators' cognitive load
- physiologically attentive user interfaces (PAUI) to enable better user performance based on their emotional and mental state

Application to:

- Unmanned Aerial Vehicles (UAVs)
- space environments

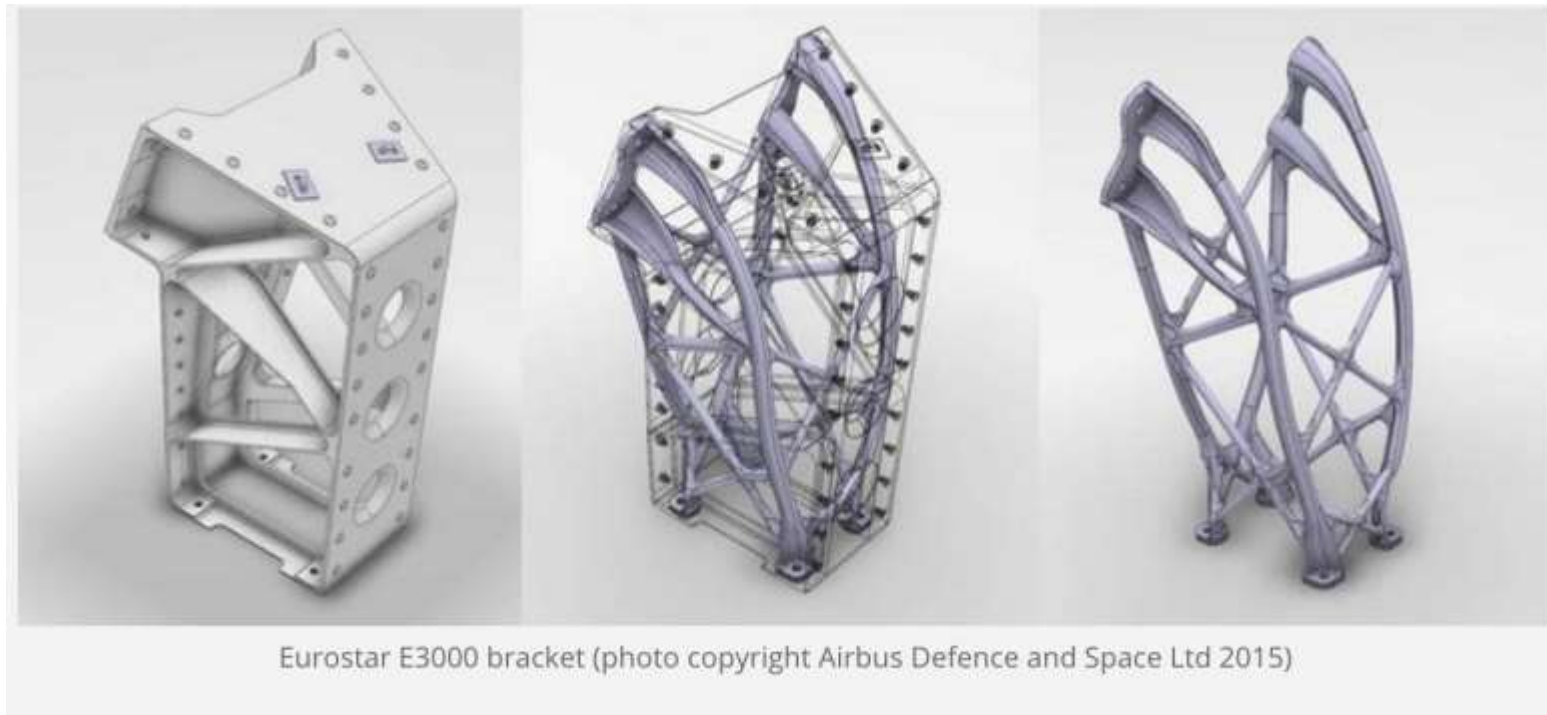
Field trials:

- Pre-selected to the AMADEE-20 Mission (analogue Mars base)
- User study with real search&rescue teams (civil and military)





AIR & Space Activities: Additive Manufacturing Products for Space Applications



Space-qualified 3D printed component from aluminum Eurostar E3000 is a generic satellite model often used for commercial and military communications (2015)



Additive Manufacturing for Space Applications

To develop a lightweight and robust antenna bracket for Sentinel satellites.

Minimum rigidity requirements exceeded by over 30%
40% weight reduction
Requirements of aerospace sector verified



The topologically optimized antenna bracket for Sentinel satellites with EOS Aluminium AlSi10Mg using additive manufacturing. (Source: EOS GmbH)

*“AM has shown that it can **fulfill the fundamental** procedural **demands** of space travel. The multiple design advantages and the characteristics of the component itself have certainly proven this. I see **great potential** for this technology going forward.”* Franck Mouriaux, General Manager Structures at RUAG

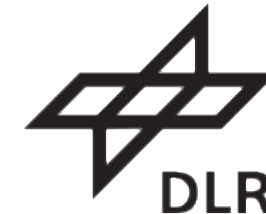


Main contributions

- i) Competence building and technology adoption in supply chain management;
- ii) Development of microturbine engines and hybridelectric propulsion systems for UAVs;
- iii) Development of robots for collaborative tasks with astronauts inside a space station environment, as the ISS;
- iv) Improvement of mass center and inertia estimation techniques and motion control of single and multiple aerial vehicles;
- v) The development of a low cost modular satellite platform with a suite of remote sensing and communication systems;
- vi) The development of methods for integration of field data, proximal sensing and remote sensing (UAV and satellite based) for environmental monitoring



End-users/Industry partners



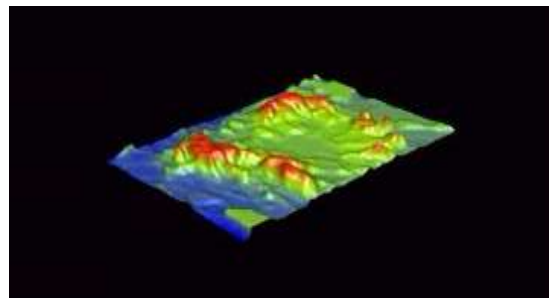
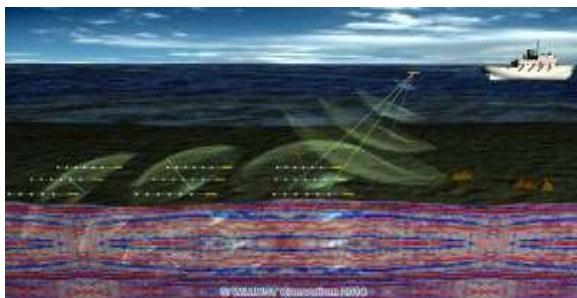


LARSyS
Laboratory of Robotics
and Engineering Systems

FCT

Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Ocean Technology Science, Engineering, and Innovation



ISR Institute for Systems
and Robotics | LISBOA

IN+


MARETEC
MARINE ENVIRONMENT & TECHNOLOGY CENTRE


m-iti
Madeira Interactive
Technologies Institute

Robotic tools for ocean exploration and exploitation

Robots and the environment:
Move, Observe, Act

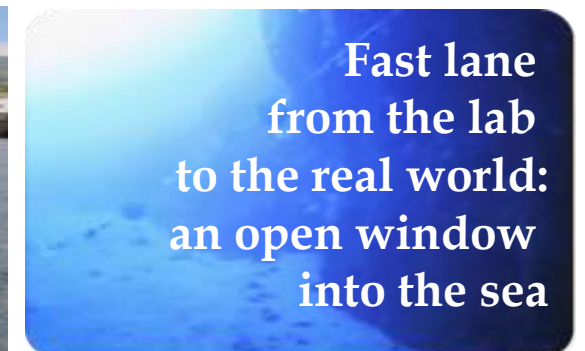
Networked Systems
at work



Bridging the gap between theory and practice:
Establishing synergies with research institutes and the industry



The work of many

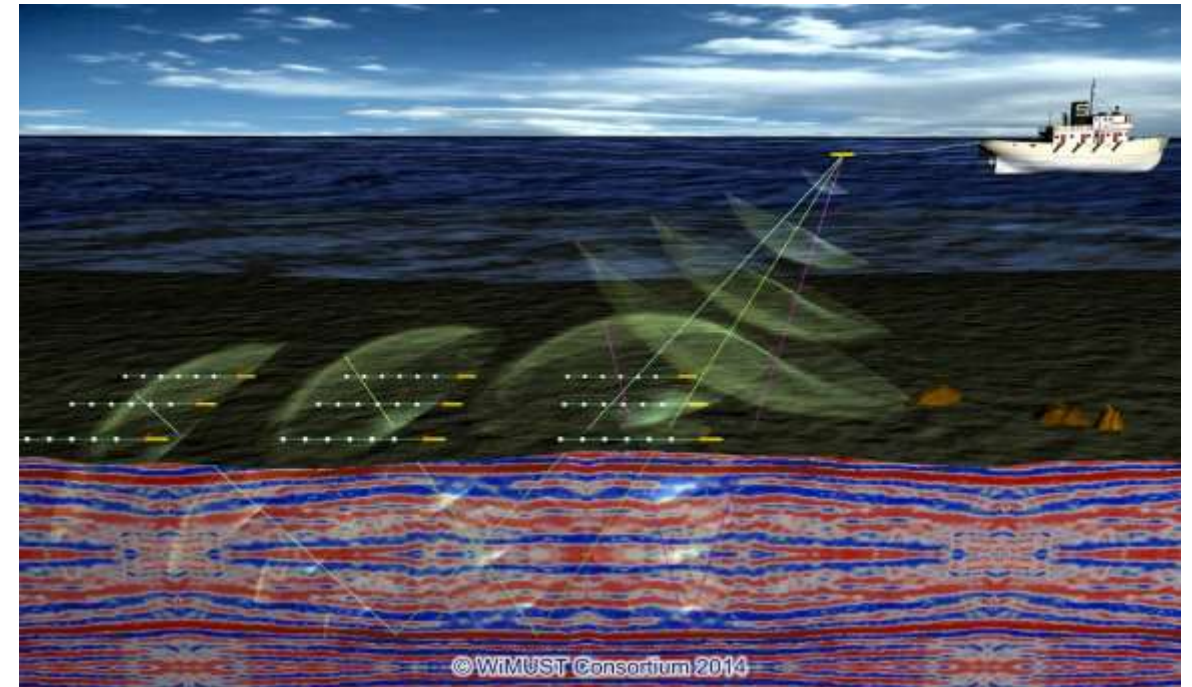
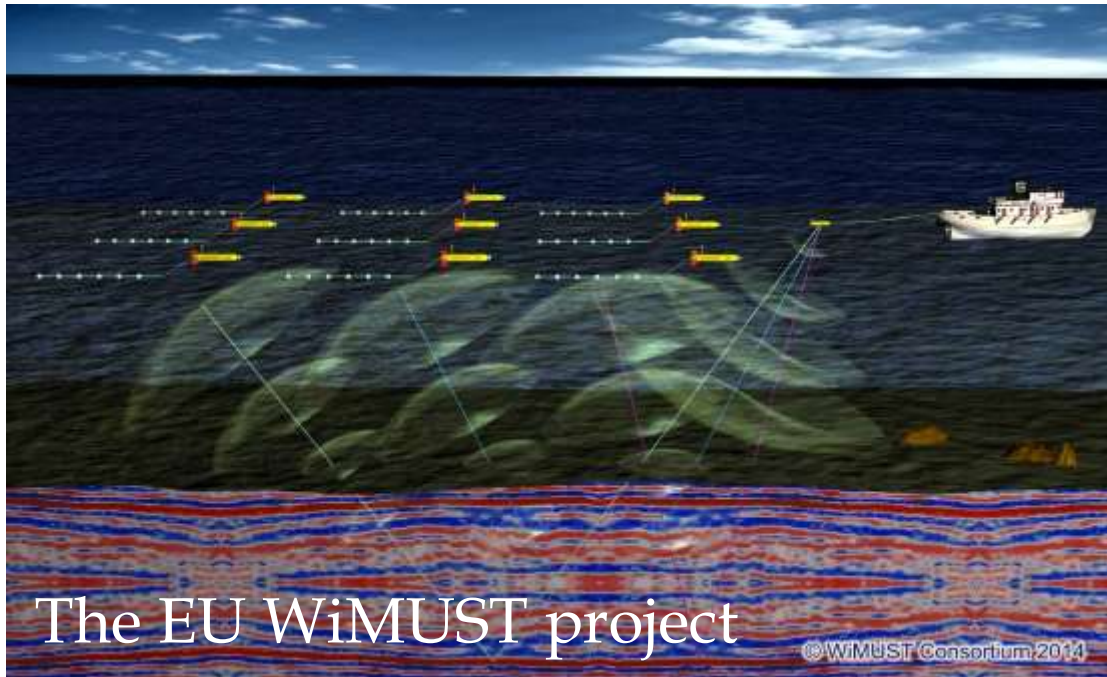


Cooperative projects with INDIA, KOREA, USA, and EU members



Geotechnical Surveying

A new robotic twist



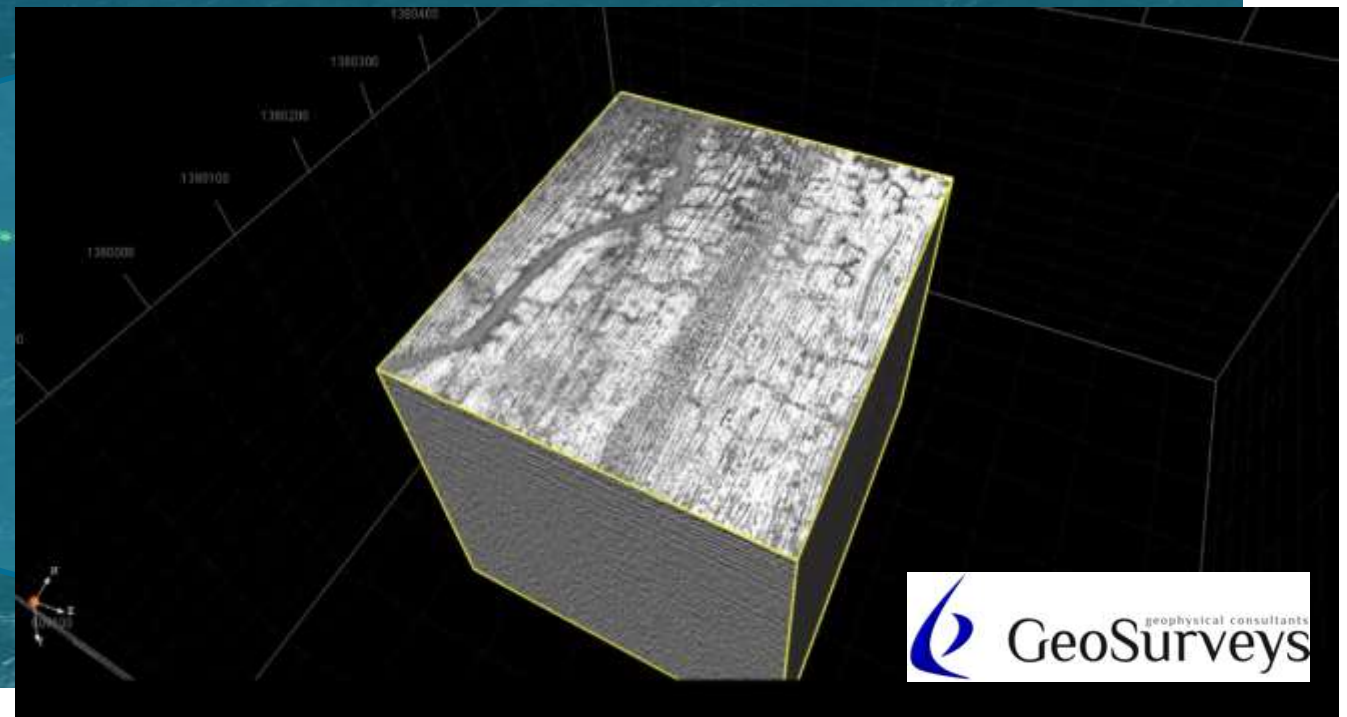
WiMUST

Widely scalable Mobile
Underwater Sonar Technology

- Autonomous sparkers
- Multiple robots with streamers: adaptive “antenna”



Field Tests in Sines, 2018



WiMUST

Widely scalable Mobile
Underwater Sonar Technology

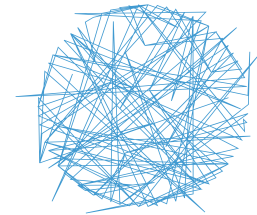
- Autonomous sparkers
- Multiple robots with streamers: adaptive “antenna”



Bridging the gap between Research and Innovation



MARINE SURVEY SYSTEMS (NL)



LARSyS



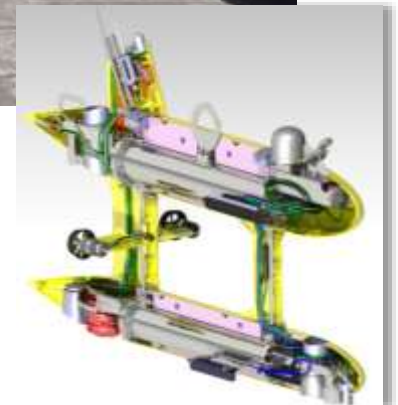
Aveiro (PT)



PÓLO DO I.S.T.



Medusa_{DS} : a new tool for Deep Seabed Mapping





SOS4ATLANTIC: the Big Picture *

A Multi-Domain Atlantic Ocean-Space Observation System: Science, Technology, and Society



* a joint MIT-PT initiative

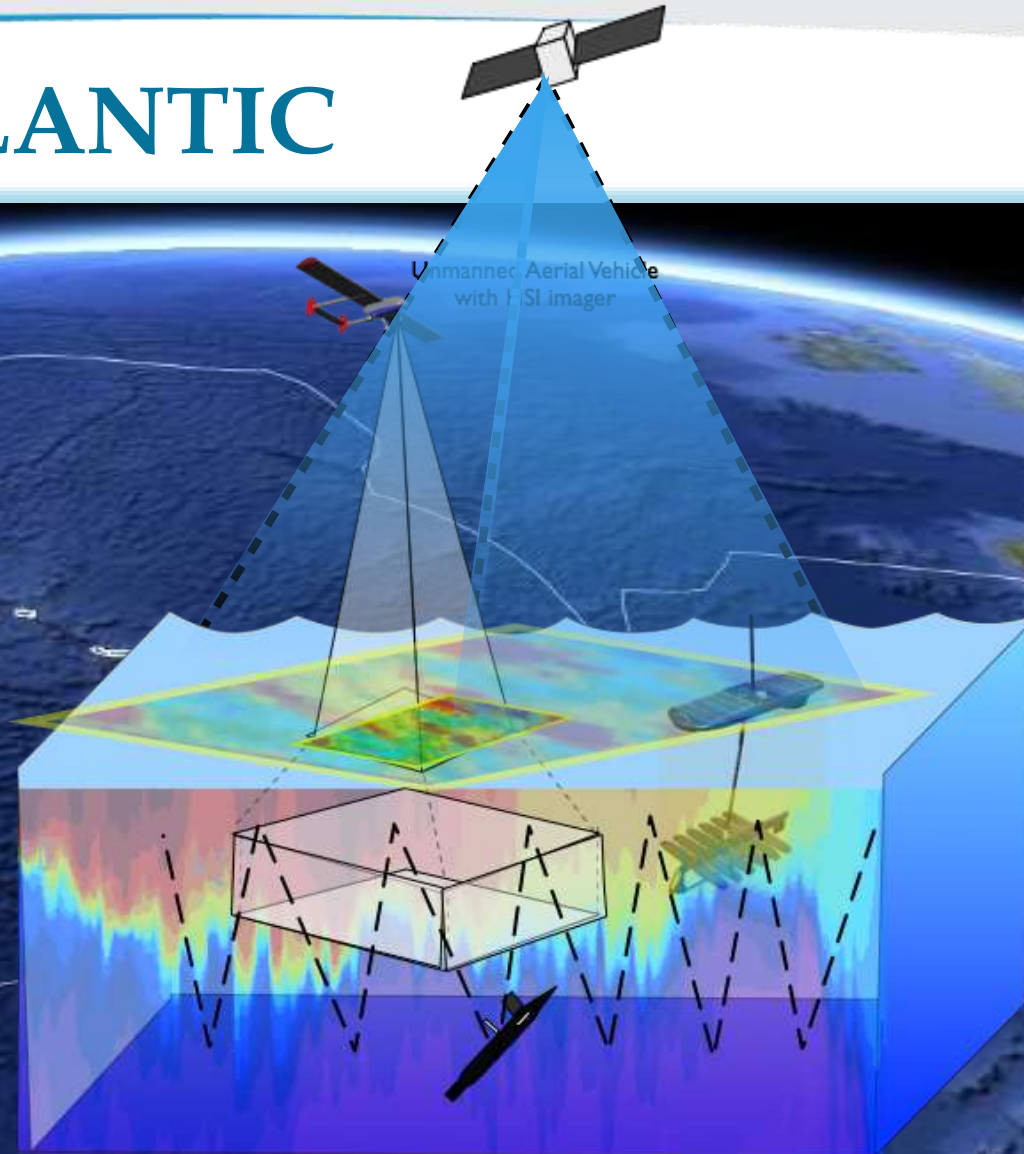


SOS4ATLANTIC

*A System of Systems approach
integrating
Space, Air, and Marine segments*

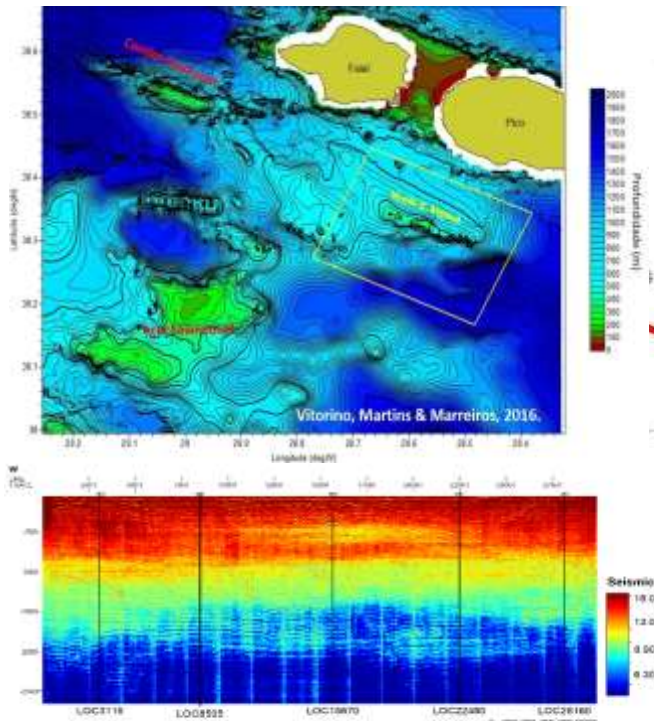
Target use-case:
Study of ocean front dynamics and how they
impact on pelagic and deep sea ecosystems

Vision:
lay the foundations for an
Atlantic Ocean Observation Platform with far
reaching scientific, commercial, and
societal impact.



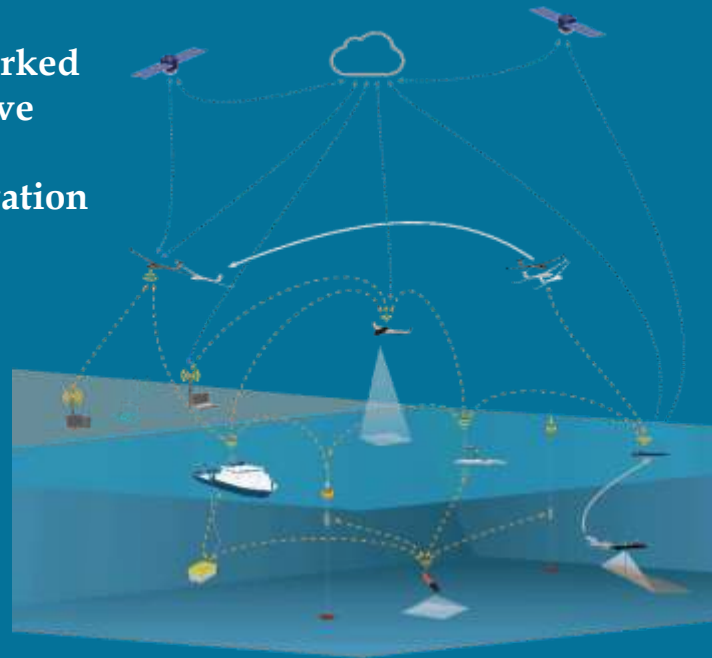


A System of Systems approach integrating Space, Air, and Marine segments for Ocean Science



Modeling and
Forecasting

Networked
adaptive
ocean
observation



Multi-vehicle SOSystems



Ocean front and
ecosystem studies



SOS4ATLANTIC:

a showcase of technological assets for science and the industry



**NRP D. Carlos class
Oceanographic Vessel**



RV Águas Vivas



**Fleet of 20 surface and underwater
autonomous marine robots – FEUP, IST, MIT**



**10 unmanned air
vehicles –
FEUP & TEKEVER**



Project methodology
from project definition to systems validation

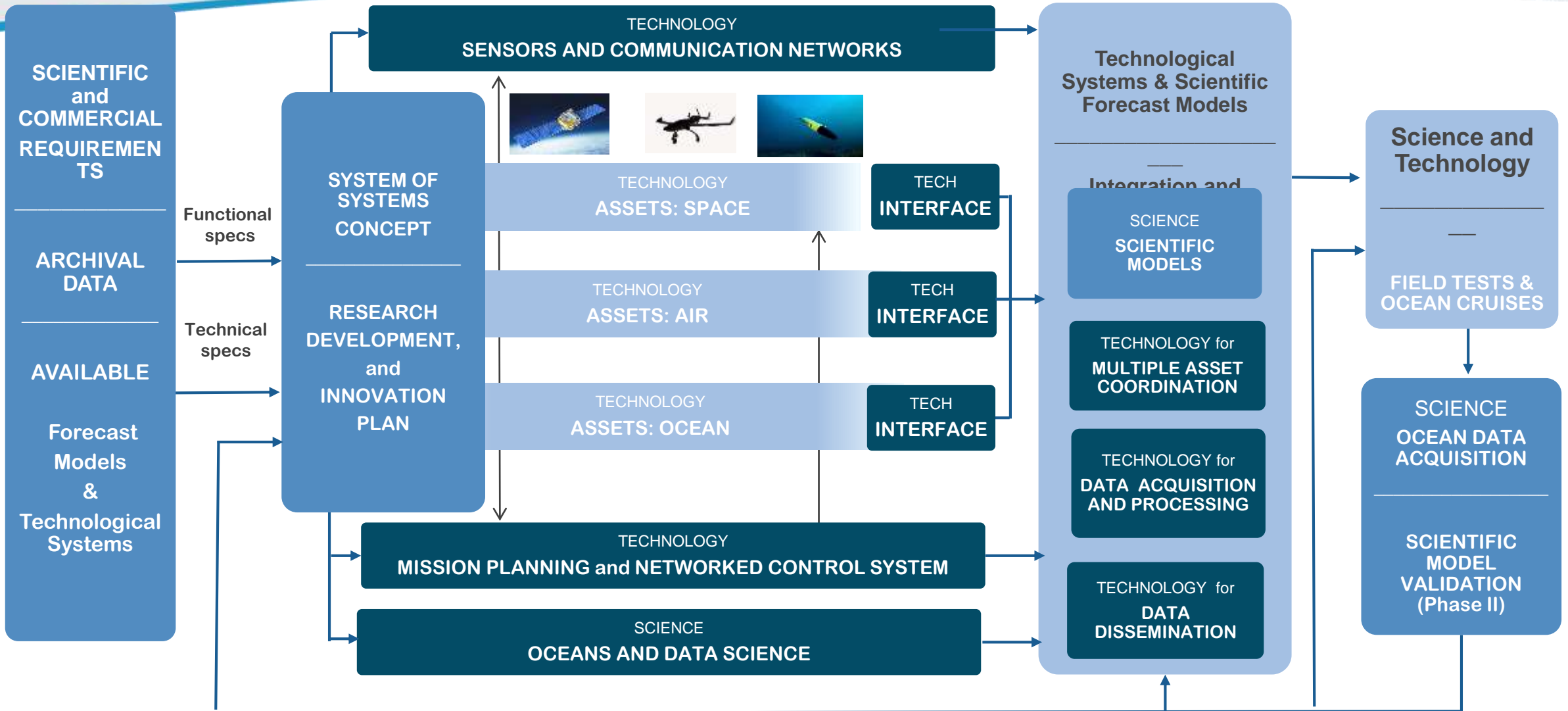
Requirements

Development

Prototyping

Integration

Demonstration

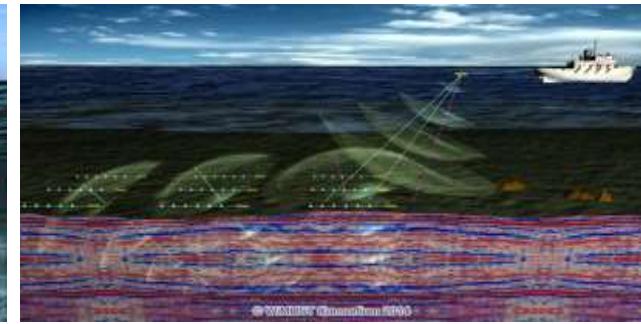
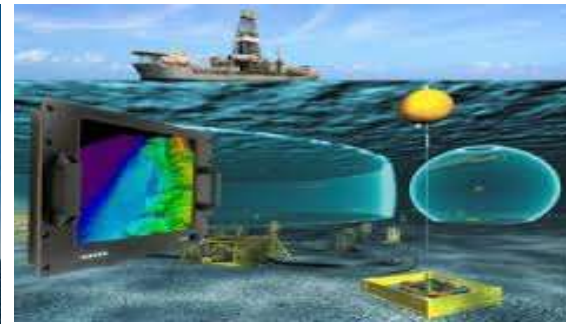




The BIG push forward

Bring about a true revolution in the marine technology area by:

- Focusing on challenging **flagship initiatives** driven by end-users (e.g. aquaculture, renewable energies, fisheries, ocean modeling and forecasting, pelagic and deep sea ecosystem studies, etc.)
- Merging innovation with core technologies for seamless access to the **water column, critical infrastructures, and the deep sea.**





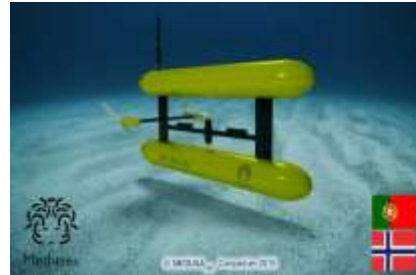
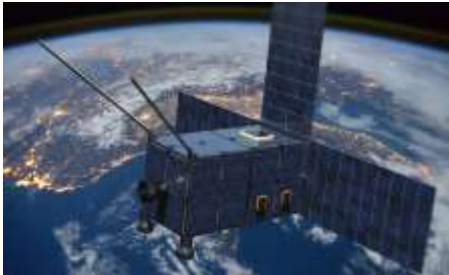
LARSyS

Laboratory of Robotics
and Engineering Systems

FCT

Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Technologies for Ocean and Space Exploration & Exploitation



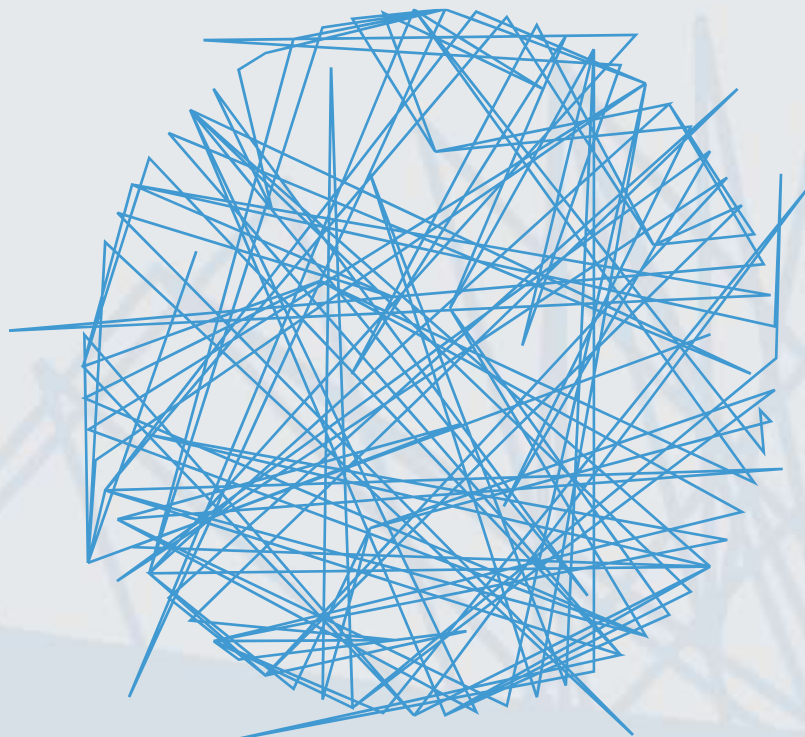


LARSyS

Laboratory of Robotics
and Engineering Systems

FCT

Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR



LARSyS

Laboratory of Robotics
and Engineering Systems

www.larsys.pt



Institute for Systems
and Robotics | LISBOA

IN⁺



MARETEC
MARINE ENVIRONMENT & TECHNOLOGY CENTER



m-iti
Madeira Interactive
Technologies Institute