



Real-time Condition-based Maintenance
for Adaptive Aircraft Maintenance Planning

Project Brochure



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programme under grant agreement No 769288

visit www.h2020-remap.eu

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About

The Advisory Council for Aeronautical Research in Europe (ACARE) envisages that, by 2050, all new aircraft will be designed for condition-based maintenance (CBM). This will result in a significant 40% reduction in Maintenance Repair & Overhaul (MRO) process time and costs, increase in aircraft availability, and maximization of asset utilization. By 2035, ACARE already foresees that this CBM philosophy will be accepted as a standard approach to monitor aircraft health and to plan aircraft maintenance. Simultaneously, however, high safety and security must be retained, with the objective of having less than one accident per ten million commercial aircraft flights. ReMAP puts together a comprehensive consortium to contribute to this ambitious vision, developing an **innovative Integrated Fleet Health Management (IFHM) solution** that, by replacing fixed-interval inspections with adaptive condition-based interventions, will have an estimated benefit to the European aviation of more than 700 million Euros per year, due to a direct decrease in maintenance costs, reduced unscheduled aircraft maintenance events, and an increased aircraft availability.



Objectives

ReMAP will contribute to reinforce the European leadership in aeronautics by developing an open-source solution for aircraft maintenance, the Integrated Fleet Health Management (IFHM) system. By replacing fixed-interval inspections with adaptive condition-based interventions, ReMAP will have an estimated benefit to the European aviation of more than 700 million Euros per year. This is due to a direct decrease in maintenance costs, reduced unscheduled aircraft maintenance events, and increased aircraft availability.

ReMAP's IFHM will be available for certification and reliable implementation on diverse aircraft systems and structures.

1

To leverage existing aircraft sensors for systems and mature promising sensing solutions for structures;

2

to develop health diagnostics and prognostics of aircraft systems and structures, using innovative data-driven machine learning techniques and physics models;

3

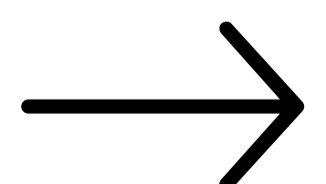
to develop an efficient maintenance management optimisation process, capable of adapting to real-time health conditions of the aircraft fleet;

4

to perform a safety risk assessment of the proposed IFHM solution, to ensure its reliable implementation and promote an informed discussion on regulatory challenges and concrete actions towards the certification of Condition-Based Maintenance (CBM).

Partners

ReMAP gathers together 13 partners, from 7 European countries that, by covering the entire value chain for aircraft health management, will establish an innovative framework, that can be used for the implementation and certification of condition based maintenance at a fleet level, while building up a European common roadmap towards the implementation of CBM.



TU Delft

Technische Universiteit Delft

Air Transport & Operations Section - is one of the few research groups in Europe working on airline operations planning and optimization, including maintenance and support.

Structural Integrity and Composites Section - is a world leading research lab for aerospace materials and structures. The group focuses on three areas: Manufacturing, Fatigue & Durability, and Structural Health Monitoring methodologies.

Valorisation Center - supports, stimulates and facilitates scientists and supporting staff of the TUD in transforming results of research and technology development to practical, commercially viable, application.

website
www.tudelft.nl



Role in this project

TU Delft will be responsible for:

- General coordination of the project (WP1);
- Development of the maintenance decision support tool (WP6);
- Active participation on the performance of SHM tests (WP4);
- Active participation on the development of prognostic algorithms for structures (WP4);
- Active participation on the safety assessment of the CBM framework (WP7);
- Test and validation of the framework (WP8).

People



Bruno F. Santos

Assistant Professor,
Air Transport &
Operations Section



Dimitrios Zarouchas

Assistant Professor,
Structural Integrity and
Composites Section



Mihaela Mitici

Assistant Professor,
Air Transport &
Operations Section



Wim Verhagen

Assistant Professor,
Air Transport &
Operations Section



Marc Boonstra

Project Coordinator,
Valorisation Center



Rikke Gammelgaard

Project Coordinator,
Valorisation Center

ATOS

Atos Spain

Atos is a global leader company in digital transformation, innovation and value creation. Atos Research & Innovation (ARI) is the R&D hub for emerging technologies and a key reference for the whole Atos group.

website
www.atos.net/spain



Role in this project

ATOS will be responsible for:

- Lead “Requirements management & IT Infrastructure” (WP2) with a special focus on the design of the IT ReMAP ecosystem and the deployment and integration features.

People



Germán Herrero Cárcel

Head of Transport Sector, Research and Innovation



Alejandro García Marchena

Technical Manager, Research and Innovation

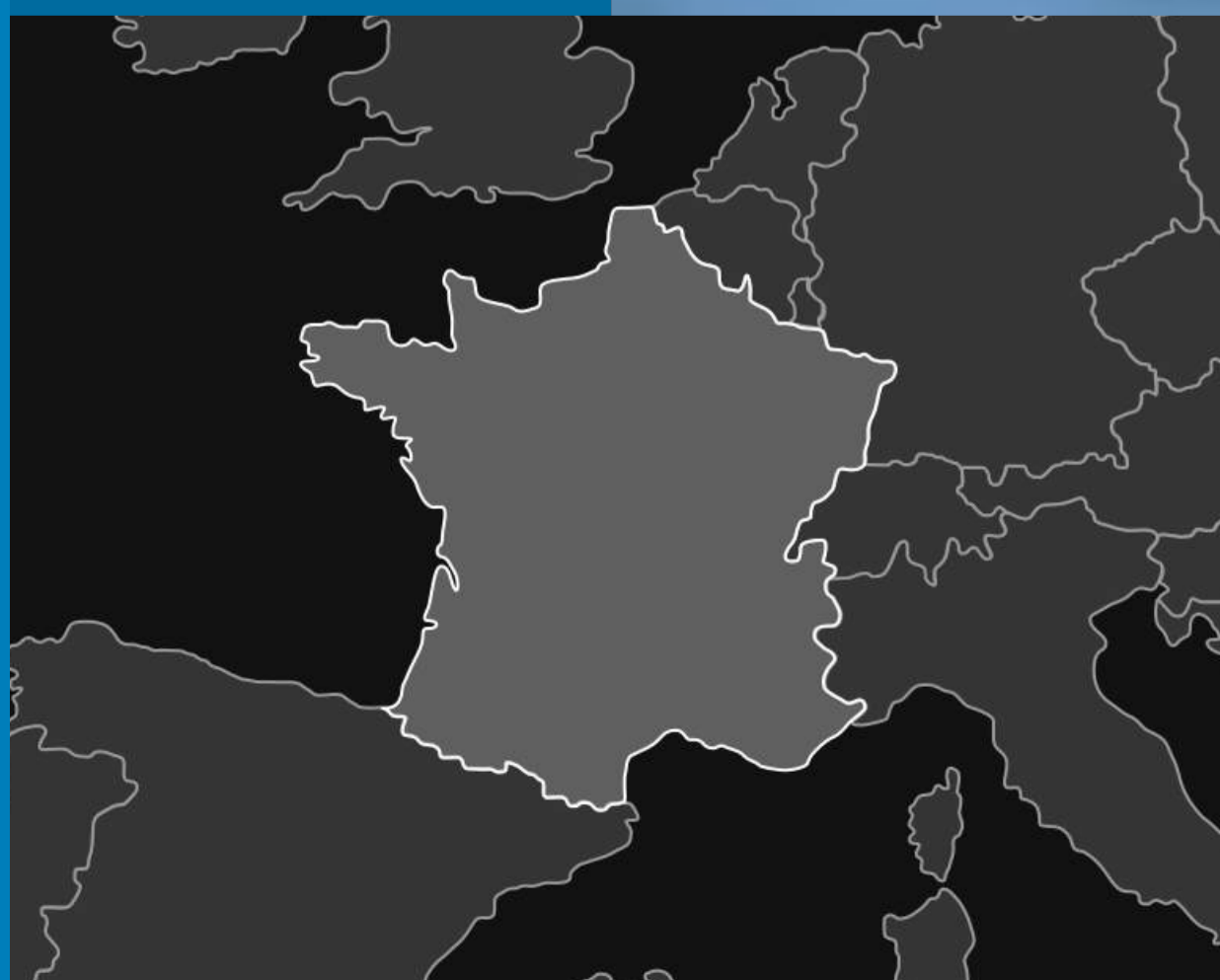
CTEC

CEDRAT Technologies

CEDRAT TECHNOLOGIES is a French Innovating SME specializing in Actuators, Sensors, Mechatronics and Detection Systems.

website

www.cedrat-technologies.com



Role in this project

CEDRAT Technologies will be responsible for:

- Manage the technical activities of ReMAP WP3 which concerns the development of the selected sensor technologies for damage monitoring and will drive the realisation of CTEC share in ReMAPS focusing on piezo solutions for SHM.

People



Nabil Bencheikh

Deputy Team Leader of Electro-Mechanisms Engineering Team, and Projects Technical Manager



Frank Claeysen

Managing Director and Sales Director

ENSAM

Ecole Nationale Supérieure d'Arts et Métiers

Arts et Métiers is a higher education engineering school in France. At Arts et Métiers, the shared goals of research and industry come together to develop projects and skills to promote the emergence of new ideas in response to rapid technological changes.

website

www.artsetmetiers.fr



Role in this project

ENSAM will be responsible for:

- Coordinate activities dealing with the active structural health monitoring (SHM) of structures by means of piezoelectric sensors;
- Active participation in the work package WP4 dedicated to SHM (development and validation of algorithms for damage detection, localization, and quantification).

People



Dr. HDR Nazih Mechbal

Associate professor responsible of the “Smart-structure” pole within the “Dynamic, Structure & Control” (DYSCO) group



Dr. Marc Rébillat

Associate Professor in the DYSCO group.



Dr. Mikhail Guskov

Associate Professor in the DYSCO group

EMBRAER

Embraer Portugal S.A.

Embraer Portugal is a Tier 1 for aerostructures fully owned by Embraer SA, third largest OEM of commercial aircraft worldwide. Embraer Portugal owns two subsidiaries, for Composite and Metallic aerostructures, specializing in wings and empennages.

website
www.embraer.com



Role in this project

Embraer will be responsible for:

- Participate in the development of new PHM algorithms, SHM technologies, ReMAP platform; demonstration and CBM discussion;
- Study of SHM technologies related with its role of aerostructures TIER I and PHM in connection with close support from its engineering in Europe;
- Participate in the discussion on the future of PHM, SHM and CBM implementation.

People



Ricardo Reis

Technical leader for Engineering Center in Portugal



Marta Quintiães

Leader of the Embraer Portugal R&D team



Ruben Menezes

Product Development Engineer

IPN

Instituto Pedro Nunes

Instituto Pedro Nunes is a non-profit private organization which promotes innovation and transfer of technology, establishing the interface between the scientific and technological system and the enterprises.

website
www.ipn.pt



Role in this project

IPN will be responsible for:

- Manage platform requirements elicitation and system architecture definition;
- Coordinate communication, dissemination and exploitation activities (WP9).

People



Professor Carlos Bento
Laboratory Director



Professor Paulo Rupino
Laboratory Director



António Damasceno
Project Manager



Mónica Ferreira
Project Manager

KLM

Koninklijke Luchtvaart Maatschappij N.V.

KLM Engineering & Maintenance is a major multi-product MRO (Maintenance, Repair, Overhaul) provider. With a workforce of over 4,000, KLM E&M offers comprehensive 24/7 technical support for airlines, ranging from engineering and line maintenance to engine overhaul, aero structure and the management, repair and supply of aircraft components, structured around a powerful logistics network. KLM E&M supports almost 175 aircraft operated by its airline. Furthermore, fleet of many other customers is supported.

KLM Cityhopper is a regional airline focused on the European network. The airline operates around 285 scheduled feeder services per day on behalf of KLM, using a fleet of 48 aircraft (including 40 Embraer's). The company transports around 7 million passenger per year and it is a 100% subsidiary company from KLM.

website
www.klm.com



Role in this project

KLM will be responsible for:

- Develop and exploit the technologies developed in the project as end-user;
- Lead 'Technology Integration, Demonstration and Validation' (WP8);
- Provide sensor, maintenance, and operational data from a fleet of Boeing 787 and Embraer's with the project in order to perform a 6-month test of the technologies developed;
- Share with the consortium their experience in developing cost- and time-saving MRO solutions, including in aspects like big data platforms, predictive maintenance solutions, and reliability engineering.

People



Ir. Hans Lucas

Engineering Unit
Leader for Cabin
& Support



Ir. Wouter Kalfsbeek

Project Leader for
Big Data development
at KLM E&M



Dr. Leon Gommans

Science Officer at
the Air France KLM
Group IT Strategy
& Technology Office



Ing. Robin Duteweerd

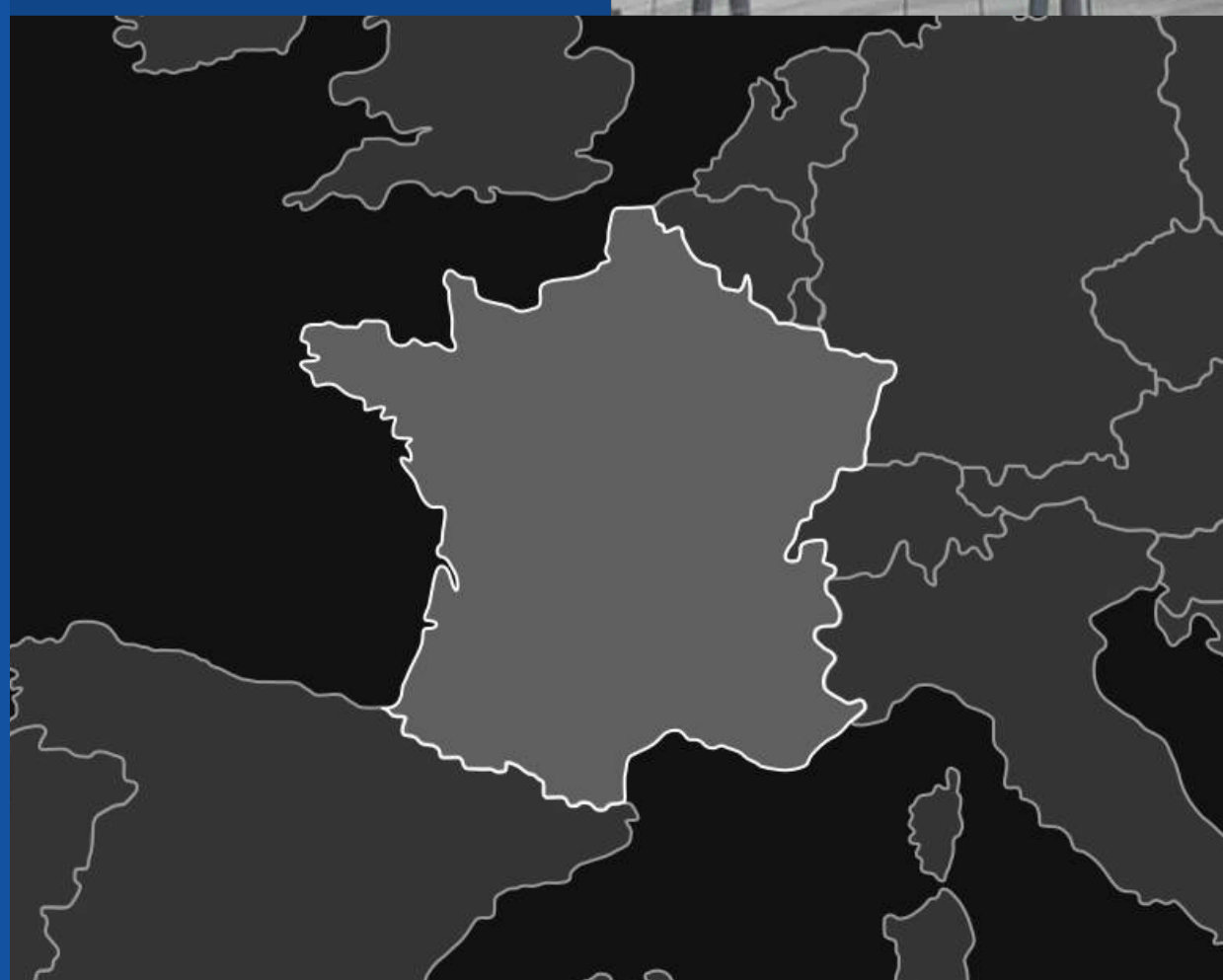
Maintenance Program
& Reliability Engineer
for KLM Cityhopper

ONERA

Office National D'Etudes et de Recherches Aeronautiques

ONERA is a French public research establishment. The research carried out at ONERA results in computation codes, methods, tools, technologies, materials and other products and services which are used to design and manufacture all that is related to aerospace. The Information Processing and Systems Department (ONERA/DTIS) have a strong experience in system modelling, safety and security analysis, stochastic simulation, detection and diagnosis.

website
www.onera.fr



Role in this project

ONERA will be responsible for:

- Active participation on 'Integrated Safety Risk Assessment' (WP7);
- Active participation on 'System Level Diagnostics, Prognostics and Health Management' (WP5) and 'Technology Integration, Demonstration and Validation' (WP8).

People



Pierre Bieber

Researcher in several EU projects that developed the model based system safety assessment approach



Xavier Olive

Specialist in operations research, data analytics and machine learning.

OPTIMAL

Optimal Structural Solutions

OPTIMAL STRUCTURAL SOLUTIONS is a Portuguese SME based in Cascais, focused on the development and manufacturing of advanced composite structures. Its core market is the aeronautical one, where we make 50-60% of our turnover. In its 8000 m² facility, OPTIMAL has fully integrated 3 main areas: Engineering, Composites and Tooling. OPTIMAL is ISO9001 certified across its business activities and EN9100 certified in one specific process, composite components trimming.

website

www.optimalstruct.optimal.pt



Role in this project

OPTIMAL STRUCTURAL SOLUTIONS will be responsible for:

- Active participation in requirements definition (WP2);
- Lead task 4.2 regarding the manufacturing of test articles with aeronautical manufacturing processes;
- Active involvement in the testing, demonstration and validation on the SHM technologies (WP8), being responsible for task 8.6 to assess potential improvements towards weight benefits.

People



Nicole Cruz
Project Manager



André Coelho
Technical Coordinator



Cristina Torres
Accounting Coordinator

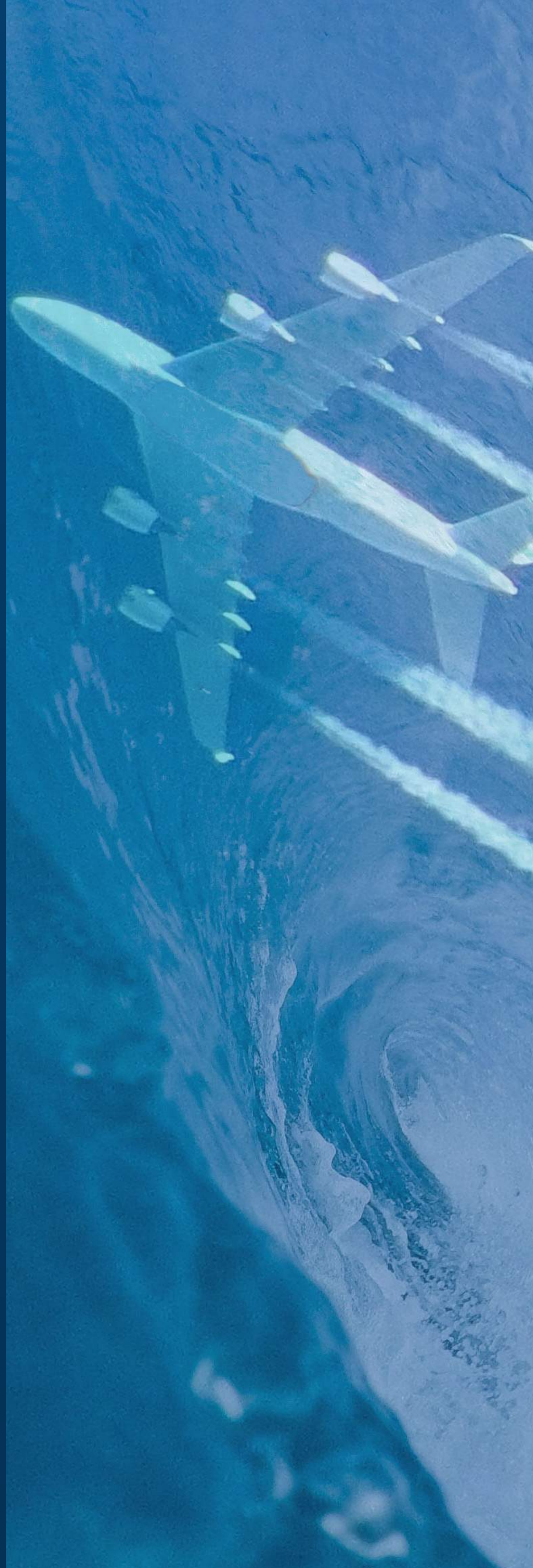
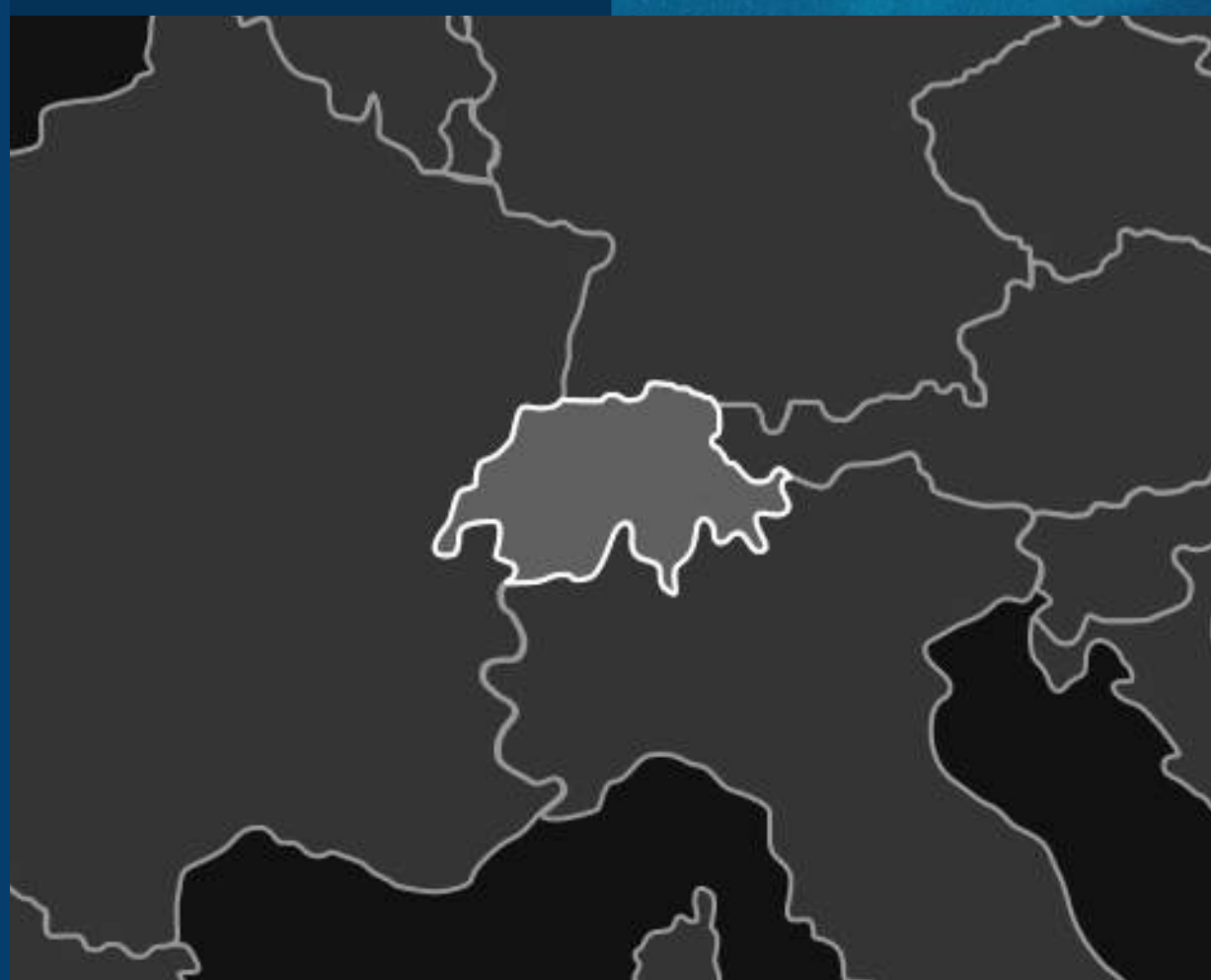
STEC

Smartec

Smartec is the leading supplier of fiber optic solutions for geotechnical and structural instrumentation. Expert in all fiber optic technologies, Smartec proposes the best solution for any requirements

website

www.smartec.ch



Role in this project

SMARTEC will be responsible for:

- Fiber optic sensing and instrumentation, producing, supplying and supporting other partners in the deployment of our sensors on the REMAP samples and demonstrator (WP3).

People



Daniele Inaudi
Chief Technology Officer



Riccardo Belli
R&D Responsible



Fabio Zanini
Field Technician

UTRCI

United Technologies Research Centre Ireland

United Technologies Research Centre Ireland, Ltd. (UTRCI), established in 2009, operates as the European hub of UTRC and is part of UTRC's mission to expand its collaborative activities while leveraging a global network of innovation. Located in Cork, Ireland, UTRCI undertakes research activities in the following fields: (a) next generation of Energy and Security Systems for High Performance Buildings, (b) cutting edge technologies for "more electric" and "more intelligent" systems for the aerospace industries.

website

www.utrc.utc.com



Role in this project

UTRCI will be responsible for:

- System level prognostics & health management and decision support tasks in WP5 and WP6 respectively;
- Data management setup and technology deployment/validation tasks in WP2 and WP8.

People



Dr. Anarta Ghosh
Staff Research Scientist



Dr. Rohan Chabukswar
Staff Research Scientist



Dr. Luis Couto
Senior Research Scientist

UC

Universidade de Coimbra

Founded in 1290, University of Coimbra (UC) Portugal is one of the oldest universities in the world. Among its eight faculties, the Faculty of Sciences and Technology (FCTUC) holds 11 departments, among which: Exact Sciences, Engineering, Architecture and Anthropology. FCTUC offers to its 7000 students a wide and comprehensive group of graduate and postgraduate courses, as well as specific life-long training programs, with a teaching staff of about 560 with widely recognized quality.

website
www.uc.pt



Role in this project

University of Coimbra will be responsible for:

- Active participation in 'System Level Diagnostics, Prognostics and Health Management (WP5);
- Active participation in 'Maintenance Decision Support Tool' (WP6).

People



Bernardete Ribeiro
Full Professor



Alberto Cardoso
Assistant Professor



Penousal Machado
Associate Professor



António Dourado
Full Professor



Joel P. Arrais
Assistant Professor



Catarina Silva
Adjunct Professor



Licinio Roque
Auxiliary Professor

UPAT

University of Patras

University of Patras was founded in the city of Patras in 1964. In ReMAP the research is going to be conducted by the Applied Mechanics Laboratory (AML). AML is part of the Department of Mechanical Engineering and Aeronautics. AML has a 30-year long experience in the field of polymer composite processing and manufacturing, material design and characterization. A vast research experience is verified through participation in various research projects programs the last years under the granting framework of European Union, European Space Agency and National Research Funds.

website

www.upatras.gr



Role in this project

UPAT will be responsible for:

- Test execution and the sensorization of test articles in WP4;
- Active participation in 'Sensor Technologies for SHM' (WP3), namely Sensor Technologies for SHM and Sensors reliability assessment.

People



Theodoros Loutas
Assistant Professor



Vassilis Kostopoulos
Professor and Director of UPAT/AML



Dr. George Sotiriadis
Mechanical Engineer

ReMAP

**We are paving the way
for the future of CBM
in aviation.**

Join us in this path!



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