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

[www.tudelft.nl](http://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 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 Claeyssen
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 Quintães**
  Leader of the Embraer Portugal R&D team

- **Ruben Menezes**
  Product Development Engineer
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.
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 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.
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 Aerospatiales

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
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
United Technologies Research Centre Ireland (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
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.

UC

Universidade de Coimbra

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
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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