



### Welcome to the third AIRMES newsletter!

The AIRMES project focuses on optimising end-to-end maintenance activities within an operator's environment. It will develop and validate an innovative, state-of-the-art, integrated maintenance service architecture that will be a key step in achieving the goal of no technically-induced aircraft operational disruptions in European air traffic. These activities will be performed within the scope of the Large Passenger Aircraft (LPA) Integrated Aircraft Demonstrator Platform (IADP) of the Clean Sky 2 Joint Undertaking (JU).

## Introduction

*The AIRMES partners are on their final stretch of the project activities. We now have less than a year to achieve our ambitious objectives and contribute to decrease technically-induced aircraft operational disruptions in European air traffic.*

*We are confident this will be possible as numerous encouraging results have already been generated. To name a few: the End-To-End (E2E) Evaluation Approach has been defined and successfully tested, the AIRMES Virtual Reality demonstrator has been showcased at ILA Berlin, the Farnborough International Airshow and Aviation Week MRO Europe.*

*In this third issue you will get to know how the activities progressed within the project work packages. The "Get Together" section will inform you about the upcoming major events related to the AIRMES research fields. The interview will let you discover the day-to-day life of people involved in achieving the project goals. I invite you to visit the AIRMES website ([www.airmes-project.eu](http://www.airmes-project.eu)) regularly updated with news and events from the project. Feel free to inform us of any activity which should be brought to the attention of the AIRMES community. We look forward to meeting with you during our future dissemination activities.*

*Enjoy the newsletter!*

*Joel Felgar Ferreira  
AIRMES Project Coordinator  
Innovation Manager  
TAP Air Portugal*

## NEWS & EVENTS

In 2018, the AIRMES partners have been very actively disseminating the results of the project. You can read the feedback from the various events on our website.

[→ Read more](#)

The partner TU Delft will represent AIRMES at the RAMS 2019 Annual Meeting in January.

[→ Read more](#)

## CONTACT US

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# E2E MAINTENANCE PLATFORM AND IHMM DEVELOPMENT AND DEMONSTRATION

## E2E Evaluation Approach has been defined and successfully tested!

The last six months have been an exciting time for the E2E evaluation team. M2P, involved in AIRMES, and DLR, involved in DEMETER, have identified and defined a comprehensive and coordinated approach to the evaluation of SOA-technologies. The E2E evaluation system combines a bottom-up and a top-down approach. The use cases (bottom) are linked via transfer functions with the proposal objectives (up).

The ADVANCE project uses the AIRTobs evaluation software and NPV-Method from DLR to calculate the impact of each SOA technology (see Figure 1). All

achieved savings and improvements are allocated to the three categories "MRO Execution", "Disruption" and "Non-productive A / C time" (see Figure 2).

The first SOA evaluation of the MPO tool has already been completed and showed estimated savings of more than 3.2 Euros million per year for the airline cluster "Small Hub & Spoke Carrier". This evaluation of the first prototype will be further specified and adapted during the course of the project. For the next six months, M2P and DLR will implement additional SOA technologies in the AIRTobs tool.

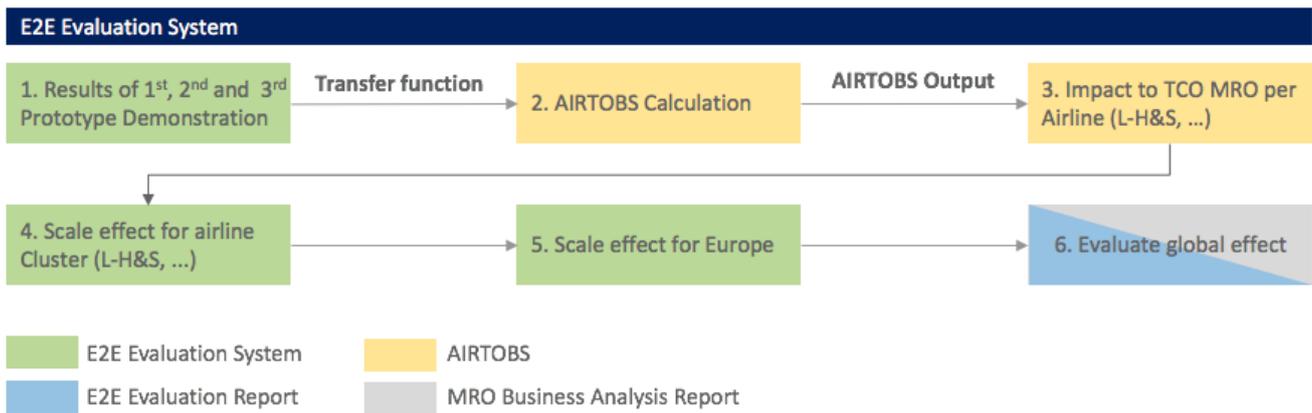


Figure 1: E2E Evaluation System.

Cost cluster	Cost component	As-Is Costs (EUR)	To-Be Costs (EUR)	Delta	
MRO Execution	A/C Data Collection and Transmission	7.724M	7.297M	445M EUR <sup>1</sup>	
	Engineering Analysis				
	Planning and Preparation				
	Execution				
	Recording				
Disruption	Unscheduled Maintenance Execution Time	858M	809M	49M EUR	6%
	Unscheduled Maintenance	4.000M	3.468M	532M EUR	13%
Non-productive A/C time	Non-productive A/C time (maintenance time)	300M	100M	200M EUR	67%
Total		12.882M	11.674M	1.226M	10%

First Prototype Evaluation of MPO-Tool achieves 3.230.000 EUR per year (S-H&S).

Remarks:

<sup>1</sup>Share of improvements according to estimated market impact – AIRMES Proposal Part BI (Technical Section)

Data Source: ICF International: MRO Market Forecast & Key Battlegrounds, 13.10.2015; Oliver Wyman: Turbulence Ahead – Disengage the Autopilot; 13.10.2015, internal analysis

Figure 2: MRO cost clusters.

## PROGNOSTIC SOLUTION DEVELOPMENT, INTEGRATION AND OPERATIONAL PERFORMANCE DEMONSTRATIONS

The aim of this work package is to create a prognostics tool that allows replacing parts at a convenient time before a failure actually occurs, rather than waiting for the part to fail and generate operational delays.

Bespoke prognostic algorithms have been developed. They are based on several years of records of maintenance and operational parameters of a European airline.



This project has received funding from the Clean Sky 2 Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 681858



The main difficulty is to identify precursory signs of a part failure before it actually fails. State-of-the-art machine learning techniques are used to identify features in the recorded data, and then look for similar trends on aircraft right after they land.

Another challenge is to find the right compromise between failure detection rate (proportion of actual part

failures detected before they occur) and the amount of false alarms (mistakenly forecasted failures of a part that is actually healthy). Optimising one criterion is usually detrimental to the other.

The various prognostic algorithms are gathered in one single tool called Global Prognostic Demonstrator. The screenshot below shows the main user interface:

Date & Time	Event	Alert Title	Provider	ATA #	A/C #	A/C Type	Status	
2018/08/22 08:13:49	Alert	Removal Needed	Prov. A	21	323	A320	Pending	ACTIONS ^
<p>Additional information from provider: Confidence level high</p> <p> <input type="checkbox"/> Invalidate/ignore alert              <input type="checkbox"/> Mark alert as an "attention" flag              <input checked="" type="checkbox"/> Plan maintenance now         </p> <p>Evaluation free text <input type="text"/></p> <p><b>EVALUATE</b></p>								
2018/08/21 01:52:12	Failure	Unscheduled Removal	-	36	322	A330	-	
2018/08/20 08:13:49	Alert	Removal Needed	Prov. A	24	323	A320	Invalidated	DETAILS v
2018/08/19 07:30:09	Alert	Soon removal of 2134F...	Prov. B	21	324	A330	Planned	DETAILS v
2018/08/18 01:52:12	Alert	Soon removal of 2...	Prov. B	36	325	A340	Attention	DETAILS v

Figure 3: Screenshot of the Global Prognostic Demonstrator.

Tests will start in fall 2018 in representative conditions, within an airline. They will allow evaluating the economical performances of this prognostic approach.

They will also help finding the sweet spot between the detection rate and the amount of false alarms.

## COLLABORATIVE AND DATA ANALYTICS ENVIRONMENT DEMONSTRATION

Collaborative Environment is a Cloud Platform dedicated to the AIRMES project. This is a Paas (Platform as a Service) providing services to facilitate partners' application deployment, data analysis, data consolidation and Knowledge Warehouse.

The platform itself received new features over the last months: a web frontend to allow partners to deploy their own applications with SSO (Single Sign-On) capabilities, improved integration of NextCloud for File Sharing with Jupyter notebooks, integration of TEKEVER's MORE backend servers and THALES's knowledge database and eLogbook application.

The technical solution of the Knowledge Warehouse feature is based on the Semantic Web technology. The platform provides services implementing the "Link Data Platform (LDP)" specification of the W3C. This technical

choice is a strategic one as it will ensure data storage, data access and data consolidation features.

Following a global initiative decided during the consortium committee in November 2017, a "Task Force", composed of experts from different domains and Semantic Web specialists, has worked on a core ontology prototype dedicated to the aeronautical maintenance domain.

Several workshops took place and resulted in a new version of the core ontology, obtained by applying a methodology allowing an efficient exploitation of the knowledge base.

Focus has been made on a consensual definition of a Work Order which is the central concept from an airline perspective.

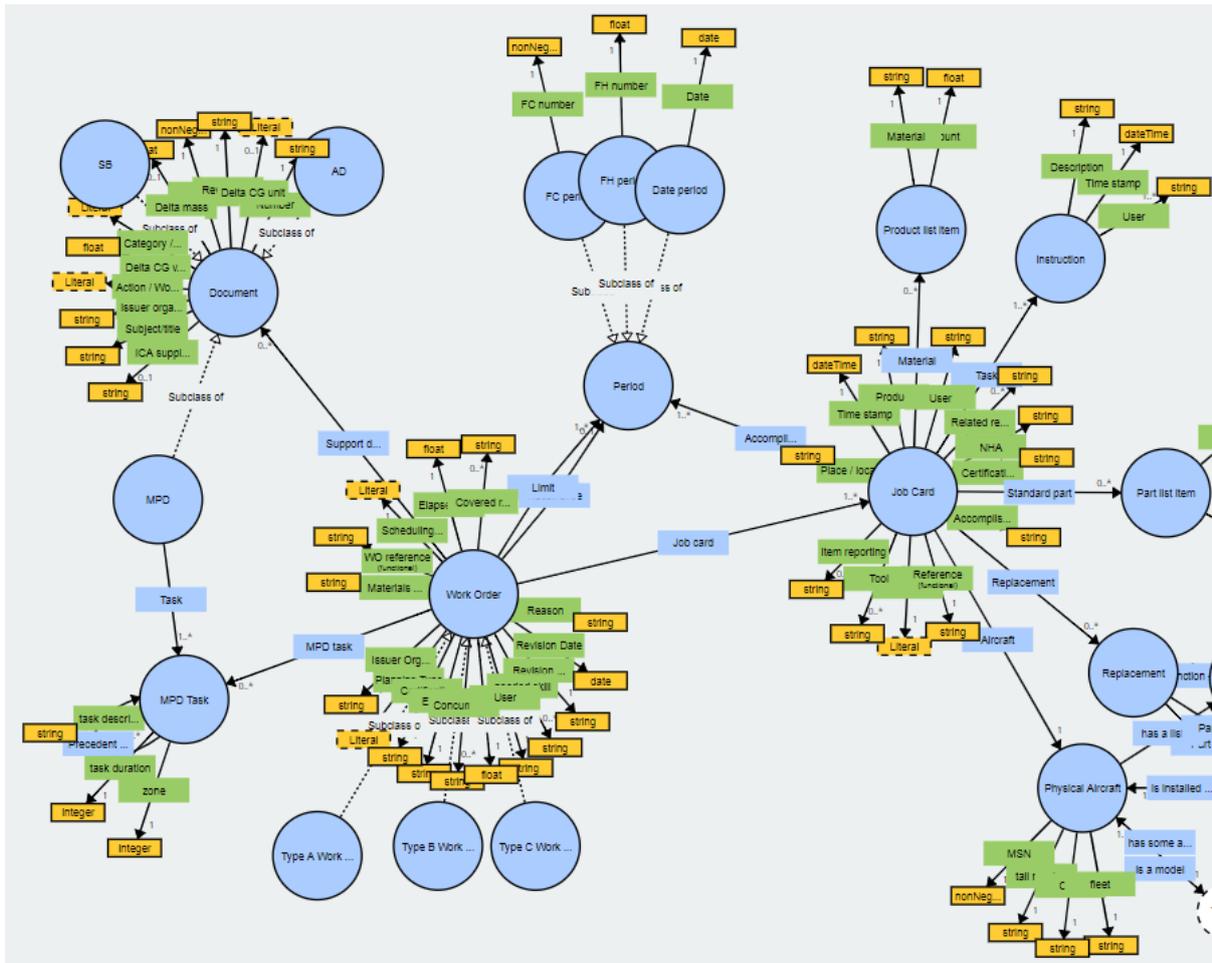


Figure 4: Work order model ontology.

The next step consists in running a set of identified scenarios centred on the lifecycle of Work Orders in order to demonstrate the benefits of a semantic web approach, regarding automatic knowledge creation through reasoning and information retrieval.

Data Analytics algorithms are still being developed. The final Data Analytics solution is planned to be integrated in the Collaborative Environment through the Jupyter Notebook feature. Cranfield University is testing and evaluating its algorithms using maintenance data provided by TAP Air Portugal. A fault prediction

algorithm for ACMS data has been investigated using deep learning approach (recurrent neural network). A pattern analysis of flight delay is performed by using dispatch reliability data. Currently, a pattern analysis algorithm for component's lifespan is being developed using historical component's removal data.

Next steps will be to finalise data analytics algorithms planned to be developed for the end of 2018.

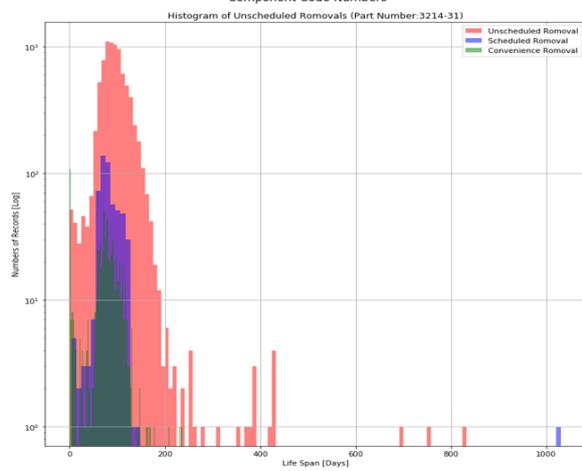
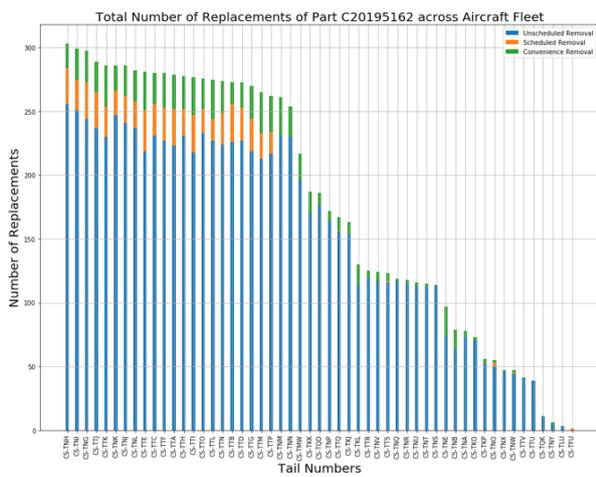
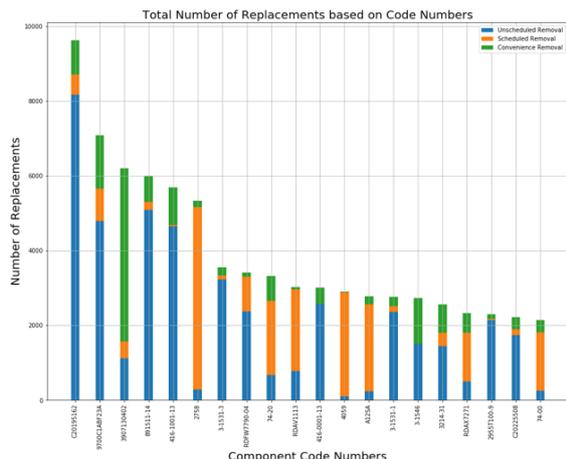
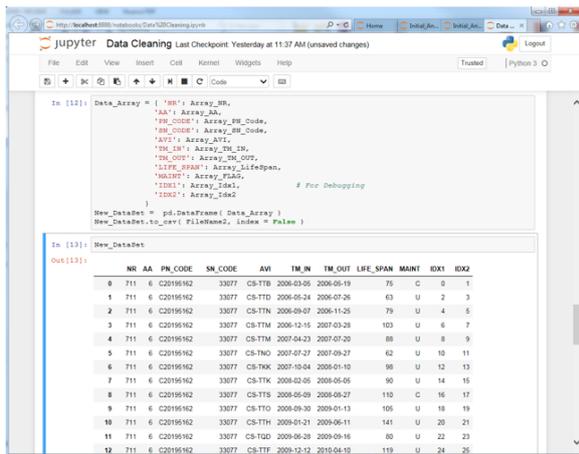


Figure 5: Pattern analysis algorithm intermediate results.

## MAINTENANCE PLANNING AND OPTIMIZATION AND CONFIGURATION MANAGEMENT SOLUTIONS

The Maintenance Planning and Optimisation module does now include a task packaging function. This function is still in an alpha version, tested and validated for a single aircraft. The main goal of the task packaging function is to allocate each task as close to its due date as possible, use tolerance only when necessary and avoid scheduling C-check tasks on A-check opportunities. This new function will be integrated with the multiple-year A- and C-check scheduling function previously developed, combining the scheduling of maintenance events with the definition of the tasks to be performed in each of the scheduled events. Regarding the Configuration Management and Configuration Capturing module, the main focus has

been on the integration with the workspace (TEKEVER) and the improvement of the prototype. A work order created in the workspace is able to update the “As Flying” configuration of the aircraft, and receive an alert if the part is not allowed in the configuration. Moreover, the source document of the work order (e.g. SB, AD, if any) is captured so it is possible to retrieve the current embodiment of a SB in the system. Concerning the prototype itself, a new step has been taken in the configuration comparison with the capacity to manage allowed configuration (Figure 6). The next step is to finish the integration phase by playing some end to end scenarios involving all the partners and continue to improve the prototype (UI).

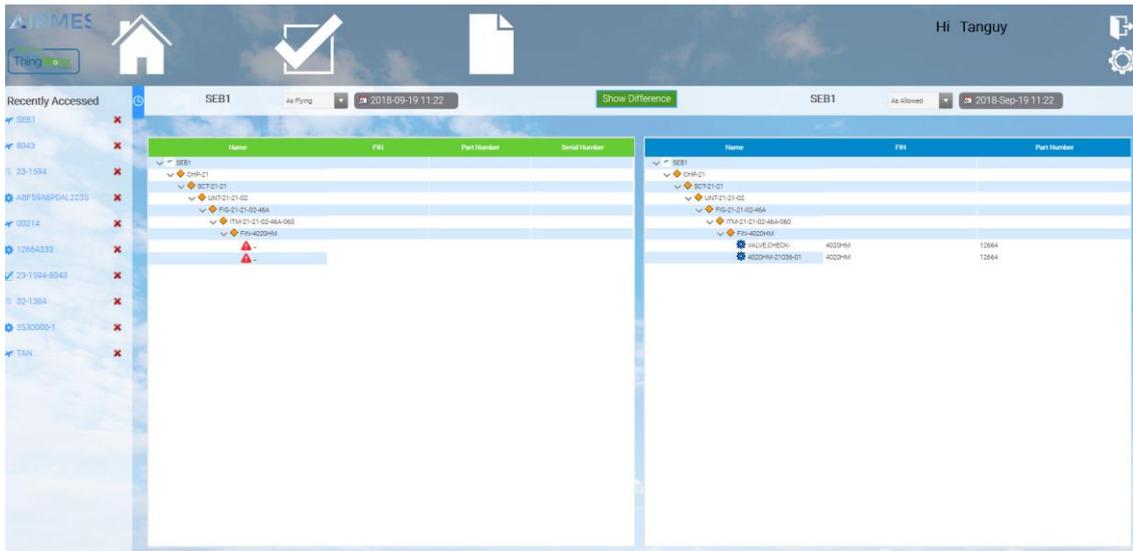


Figure 6: Configuration Management module – Aircraft ‘as allowed’ configuration comparison result.

## INTEGRATED MOBILE SOLUTIONS FOR MAINTENANCE EXECUTION ENHANCEMENT

The tools developed in this work package (WP) have made a huge progress during the last months.

In 2018, on the top of the development of the features of individual technological bricks, the AIRMES partners had the challenge to prioritise their integration. In order to enable that, two major physical integration workshops with all integration stakeholders were organised, on the top of other smaller workshops. The outcome of these workshops was very positive and encouraging.

In what regards individual features, several of them were tested with key end-users, also with very positive feedback.

In 2018, the AIRMES project was invited by the CSJU to display the Virtual Reality prototype at the Clean Sky 2 stand in the ILA Berlin Airshow and in the Farnborough Air Show.

Several people from all spectrums (EC representatives, academics, engineers, students, general public...) tested the prototype and were very impressed with both the quality and the achievement made in such a tight timeframe. It was also an opportunity to disseminate other AIRMES activities and distribute other dissemination materials (e.g. leaflets).

So far, 2018 was a very promising year in this WP. Yet, more challenges are to come. One of them being the next critical milestone in October i.e. the integration workshop, already in preparation for the final demonstration of the Final Demonstration in operational environment scheduled for the second quarter of 2019.



Figure 7: AIRMES VR tool tested in the CSJU stand at the ILA Berlin Airshow.



Figure 8: AR tool being tested by TAP's line maintenance.

## GET-TOGETHER

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### **AIAA SCITECH 7-11 JANUARY 2019, SAN DIEGO, CALIFORNIA, USA**

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The 2019 AIAA SciTech Forum will explore how our industry is being transformed by on-demand delivery of customized products and services. Learn how advances in additive manufacturing, high-speed networked computers, autonomous systems, and big data analytics, are reshaping aerospace supply chains, improving productivity, and opening the market to new entrants. Source: [AIAA SciTech 2019](#).

### **RAMS ANNUAL MEETING 28-31 JANUARY 2019, ORLANDO, FLORIDA, USA**

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RAMS ® is the leading global conference for Reliability and Maintainability (R&M) professionals combining tutorials, presentations, CEUs, certifications, and networking into one weeklong program.

RAMS ® 2019 will bring together an international audience of R&M leaders and professionals, in depth sessions and tutorials presented by top R&M experts, exhibit floor featuring leading companies, keynote session insights, networking and job related opportunities, and more. Source: [RAMS 2019](#).

The AIRMES partner TU Delft will present the following topic: “A Mobile Decision Support System for Aircraft Dispatch”.

### **PARIS AIR SHOW 17-23 JUNE 2019, PARIS, FRANCE**

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The 53<sup>rd</sup> Paris Air Show will take place at the Le Bourget Parc des Expositions from 17 to 23 June 2019, and once again will bring together all the players in this global industry around the latest technological innovations. The first four days of the Show will be reserved for trade visitors, followed by three days open to the general public. Source: [Paris Air Show 2019](#).

### **AIAA AVIATION FORUM 17-21 JUNE 2019, DALLAS, USA**

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The AIAA Aviation and Aeronautics Forum and Exposition will combine the best aspects of technical conferences with insights from respected aviation leaders. Source: [AIAA Aviation Forum 2019](#).

### **EURO 2019 23-26 JUNE 2019, DUBLIN, IRELAND**

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The 30<sup>th</sup> European Conference on Operational Research Researchers will gather academics, practitioners, and students interested in any branch of Operational Research, mathematical modelling and economic analysis. Source: [EURO 2019](#).

### **ATRS CONFERENCE 2-5 JULY 2019, AMSTERDAM, NETHERLANDS**

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The 23<sup>rd</sup> ATRS World Conference will focus on the issue of airline and airport capacity constraints, and their effects on tourism, high-speed rail and the broader economy. Furthermore, Open Skies between North America and Europe, and the Brexit will be included in the discussion. Source: [ATRS 2019](#).

### **EUROMAT 1-5 SEPTEMBER 2019, STOCKHOLM, SWEDEN**

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EUROMAT 2019, the European Congress and Exhibition on advanced materials and processes, is the premier international congress in the field of materials in Europe addressing the following technical subject areas: functional materials, structural materials, processing, characterization and modelling, energy and environment, raw materials and bio-based materials. Source: [EUROMAT 2019](#).

### **EASN INTERNATIONAL CONFERENCE 2019 3-6 SEPTEMBER 2019, ATHENS, GREECE**

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The 9<sup>th</sup> EASN International Conference on Innovation in Aviation and Space will include a number of plenary talks by distinguished personalities of the European Aviation and Space sectors from academia, industry, research community and policy makers. It will also include thematic sessions, along with technical where evolving ideas, technologies, products, services and processes will be discussed. Research projects are invited to exploit the opportunity and disseminate their results and achievements in dedicated Sessions.

The conference is co-organised by the EASN Association, the University of Patras and the National Technical University of Athens Source: [EASN International Conference 2019](#).

### **INFORMS 20-23 OCTOBER 2019, SEATTLE, USA**

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The Annual Meeting of the Institute for Operations Research and the Management Sciences (INFORMS) will address best practices and advances in operations research, management science, and analytics to improve operational processes, decision-making, and outcomes. Source: [INFORMS 2019](#).



## INTERVIEW

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AIRMES newsletters offer you the possibility of getting to know some of the project partners a little better... Thus, the interviews section will let you discover the day-to-day life of the people involved in achieving the AIRMES goals.

In this edition of the AIRMES Newsletter # 3, we propose you several tags which will lead the interview: **objectives and stakes – mobile tools – technologies – potential – capabilities - Virtual Reality demonstrator.**

### **LUIS OLIVEIRA INNOVATION SPECIALIST MRO - MAINTENANCE, REPAIR & OVERHAUL, TAP AIR PORTUGAL**

**Q1:** You are the leader of work package 6 (WP6) “Integrated Mobile Solutions for Maintenance Execution Enhancement” within AIRMES. Can you please remind us the **objectives and stakes** of this work package?

**A1:** This WP concurs to the objective of reducing operational interruptions by increasing the efficiency of line maintenance works. Line maintenance technicians face a very stressful environment, with high operational pressure, little time to work, all coupled with the need for delivering answers to a huge variety of problems while working alone or in very small teams.

Therefore, it was identified the need for having integrated mobile tools to provide fast access to relevant and contextualised information, decision support systems, and remote support. Paramount to the successful acceptance of these tools is also the smooth and seamless integration.

**Q2:** What are the challenges of developing the **mobile tools** in AIRMES?

**A2:** There are several challenges: we are developing different tools by different people geographically dispersed that, in the end, will all have to be integrated to serve the same purpose – to help the line maintenance technicians do their job. The communication flows between the project partners can also be a challenge, nevertheless, this has been smoothed especially after the first months of AIRMES. Now, the epicentre is shifting more to the second major challenge: integration and technical coherence. Several physical workshops have been organised and we have been able to overcome the problems we found. I must say that I’m working with an excellent team, making the challenges more interesting than worrying.

**Q3:** How do the technicians interact with all the **technologies**?

**A3:** The technologies were designed by answering a multitude of requirements and specifications that were set by the future end-users – Aircraft Maintenance Technicians and back-office support departments. We had several immersion days and workshops in TAP Line Maintenance and other back-office departments. Then, after setting the different requirements and specifications, we had several intermediate prototypes tested at TAP with the relevant end-users, which allowed us to ensure that the development is on the right track. And this is, in my view, the main driver of this project and its success – we work for the end-user.

**Q4:** TAP Air Portugal is involved in AIRMES as the future industrial user of the developed solutions. From your perspective, what is the **potential** of the mobile tools in the value chain?

**A4:** The potential of the solutions is overall very good. They are delivering very good results and I think we are on the right track to have a successful final demonstration in the Spring 2019. If this is the case, I am confident that the business case to implement the mobile tools in the actual workplace will be competitive.

**Q5:** What are the needs of these technologies to release the full **capabilities**?

**A5:** Some of these technologies will be tested for specific use-cases. We will reach a satisfactory degree of maturity, but we know that it is always challenging to increase the scope to address the full needs in the way an industrialised off-the-shelf product is expected to perform. Also, the integration of a part of these tools with legacy airline IT systems may also pose some difficulties that will need specific solutions, yet to be studied and addressed.

**Q6:** You have been very actively disseminating the results of AIRMES. This year, you participated in ILA Berlin and the Farnborough International Air Show to showcase, together with ISQ, the **Virtual Reality demonstrator**. What was the feedback of the visitors on your work? Are there any upcoming events at which the public can try the AIRMES demonstrator out again?

**A6:** I also want to add that the prototype was also demonstrated last month on TAP’s stand at MRO Europe 2018. Overall, the acceptance of the prototype was very good! The public in general was enthusiastic. However, I must say that at MRO Europe we had the most encouraging feedback – our prototype was tested by several people in the industry and they provided very good comments. Feeling that our industry peers are enthusiastic about the prototype is very reassuring, since it confirms that what we are developing makes sense and is addressing industry-wide needs.