



# PROJECT PERIODIC REPORT

## PUBLISHABLE SUMMARY

**Grant Agreement Number:** 284562

**Project Acronym:** SARISTU

**Project Title:** Smart Intelligent Aircraft Structures

**Funding Scheme:** FP7, 4<sup>th</sup> call Aeronautics

**Date of the last version of Annex I against which the assessment will be made:**  
2012-03-26

**Periodic report:** 1<sup>st</sup>  2<sup>nd</sup>  3<sup>rd</sup>  4<sup>th</sup>

**Period covered:** from 01.09.2012 to 31.08.2013

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## 1. Publishable summary

### *Summary description and main objectives*

SARISTU – **S**m**A**Rt Intelligent Aircraft **S**T**R**uctures ([www.saristu.eu](http://www.saristu.eu)), is a level 2 project conducted within the European Union's 7th Framework programme addressing the air travel cost reduction aspect of the 4th call.

As such, SARISTU's principal aims target a reduction of the manufacturing and in particular the operational cost of civil airliners. For this purpose, it matures and integrates different concepts which enable further fuel burn reductions through aircraft drag and weight reductions, reduce aircraft downtime in case of unscheduled inspections and improve the manufacturing times and subsequent performance of advanced fuselage structures.

Organized along the major principal components of an aircraft, development and integration activities centre on wing specific applications on one hand and fuselage applications on the other hand.

Wing specific applications cover the implementation of conformal morphing on the leading and trailing edges of the wing as well as the trailing edge of the winglet. Furthermore, the wing box will feature integrated Structure Health Monitoring for loads monitoring and rapid damage detection and assessment. Besides the reduction of mission specific fuel burn, further beneficial side effects address noise reduction and rapid aircraft turn around following accidental damages.

Fuselage specific applications cover the implementation of Structure Health Monitoring in typical fuselage structures for rapid damage detection and assessment as well as the provision of low-cost electrical functionality in composite structure and the utilization of Nanoparticles for electrical isotropy improvement and damage tolerance enhancement. Besides improved aircraft turnaround times following accidental damages, benefits regarding airframe robustness and hence weight are targeted.





### *Description of the work performed to date*

At present, SARISTU has completed its first two years out of the four year project duration. While the key objectives for the first reporting period focused around the initiation of the individual working groups, processes, process refinement and, above all, the collation and development of the required specifications and initiating the first test series and top level design requirements, the second reporting period focused on very different activities. The key activities during this period can best be grouped into two major categories. In particular with respect to the wing integration, the majority of work conducted focused on design activities, both non-specific and specific. On the other hand, and in particular where the fuselage integration was concerned, progress on the application scenarios physical integration test campaigns was at the forefront.

Of particular importance was the progression on the specific design of the wing integration demonstrator to be “flown” in TsAGI's T-104 wind tunnel in 2015. Requiring a significant coordination between the Integration Scenario and the feeder Application Scenario's addressing the morphing components on the leading edge, trailing edge and winglet trailing edge as well as the Structural Health Monitoring Scenarios integrating Fibre Optic monitoring into the wing box and the morphing trailing edge as well as acoustic damage detection and assessment into the wing box which will also contain nanoparticle reinforced manhole covers the SARISTU consortium has achieved the near completion of the detailed design of this major test piece. Of particular importance is the sufficient maturity of the design to initiate the part manufacture right at the start of the third reporting period. This achievement would not have been possible without the individual Application Scenarios excellent progress in, for example, narrowing down bird strike solutions for the leading edge spar by simulation, the manufacture of two out of the four planned dummy structures for system integration trials for the trailing edge and the system safety and robustness assessment for the wingtip active trailing edge to name but a few. Similarly, initial test campaigns resulted in the refinement of fibre optic tapes for easy and rapid integration and algorithm maturation for acoustic damage detection. On the fuselage integration, the test campaigns for acoustic damage detection and assessment are progressing fast with a range of manufacturing concerns already addressed satisfactorily, simulations indicating the key parameters of importance during multi-site damage events, test results coming in for a down selection of suitable solutions for damage indicating surfaces, manufacturing trials having been completed for co-bonded metallic strips for low cost Electrical Structure Network integration and of course the initial test campaign for different Carbon Nanotube integration routes having been completed.



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As such, overall progress is fully meeting expectations as is perhaps best highlighted by the 72 publications and dissemination activities already made by the consortium partners within the first half of the project.



### ***Expected final results***

With respect to the wing specific applications, the further maturation and development of conformal morphing technologies, which enable a smooth shape change of aerodynamic surfaces, as well as the integration of structural health monitoring are at the focus of activities. To date, conformal morphing surfaces can not be implemented in practice due to the conflicting requirements of a high required structural stiffness and the ability to be actively deformed. Furthermore, additional functionalities have to address specific aircraft requirements such as lightning strike protection, bird strike protection, erosion protection and a reliable integration of different sensor systems into the control architecture. By enabling the consideration of conformal moving surfaces at the aircraft design stage, SARISTU expects to reduce the fuel consumption of future airliners by up to 6% while at the same time offering improvements in flight path noise.

Fuselage specific applications centre on the integration of Structural Health Monitoring technologies in the aircraft architecture as well as the further maturation of multifunctional structures and the improvement of a typical fuselage's robustness. By enabling a significantly more rapid damage assessment and categorization than is currently possible, aircraft structural inspections due to accidental damages are expected to be performed with a significantly reduced flight delay. This in turn is expected to result in a cost reduction of such in-service inspection activities of up to 1% for carbon fibre based fuselage structures. Furthermore, advantages from such on- and off-line monitoring systems can be combined with achievable improvements in the structures damage tolerance. Such improvements are investigated and developed within SARISTU's multifunctional structures approach which, among other solutions, integrates Carbon Nanotubes in the basic skin-stringer-frame system. Resulting improvements can be exploited either directly for an improved structural robustness or translated into structural weight savings of up to 5% for the skin-stringer-frame system.

Multifunctional Structures also incorporate the exploitation of Carbon Nanotube electrical conductivity in order to enable a carbon fibre based structure to perform low level electrical functionalities. Together with further technological integration targeting the higher electrical functions such as electrical grounding and bonding, it is expected that the currently heavy and costly Electrical Structure Network required with a black fuselage can be designed significantly lighter and installed approximately 15% more cheaply.

Culminating in wing and fuselage specific demonstration and performance verification activities in its fourth and final year, SARISTU is expected to bring benefits beyond its current scope of more affordable air travel. While conformal morphing can in principle be applied to



further aerodynamic surfaces, it could also bring benefits to other industries where active aerodynamic or fluidic control is beneficial. Similarly, Structural Health Monitoring can be expected to bring in particular operational benefits wherever light weight construction is of primary importance. Last-but-not-least, overcoming technical obstacles related to the electrical properties of composite structures as well as the integration of data generation and transmission into composite structures will be applicable well beyond the aircraft industry.