



ITD Systems for Green Operations
Publishable summary 2013 Annual Progress Report
Reporting Period
1st January 2013 – 31st December 2013

Publishable Summary

Most activities of the Systems for Green Operations ITD have been fully active in 2013. This encompasses:

- Definition of Aircraft Solutions and exploitation strategies;
- Development of technologies for the Management of aircraft energy;
- Development of technologies and functions for the Mission and Trajectory Management links to the SESAR JU developments;
- Improved ground operations;
- Large-scale demonstration for large aircraft applications.

These activities are organized along the following work-package structure :

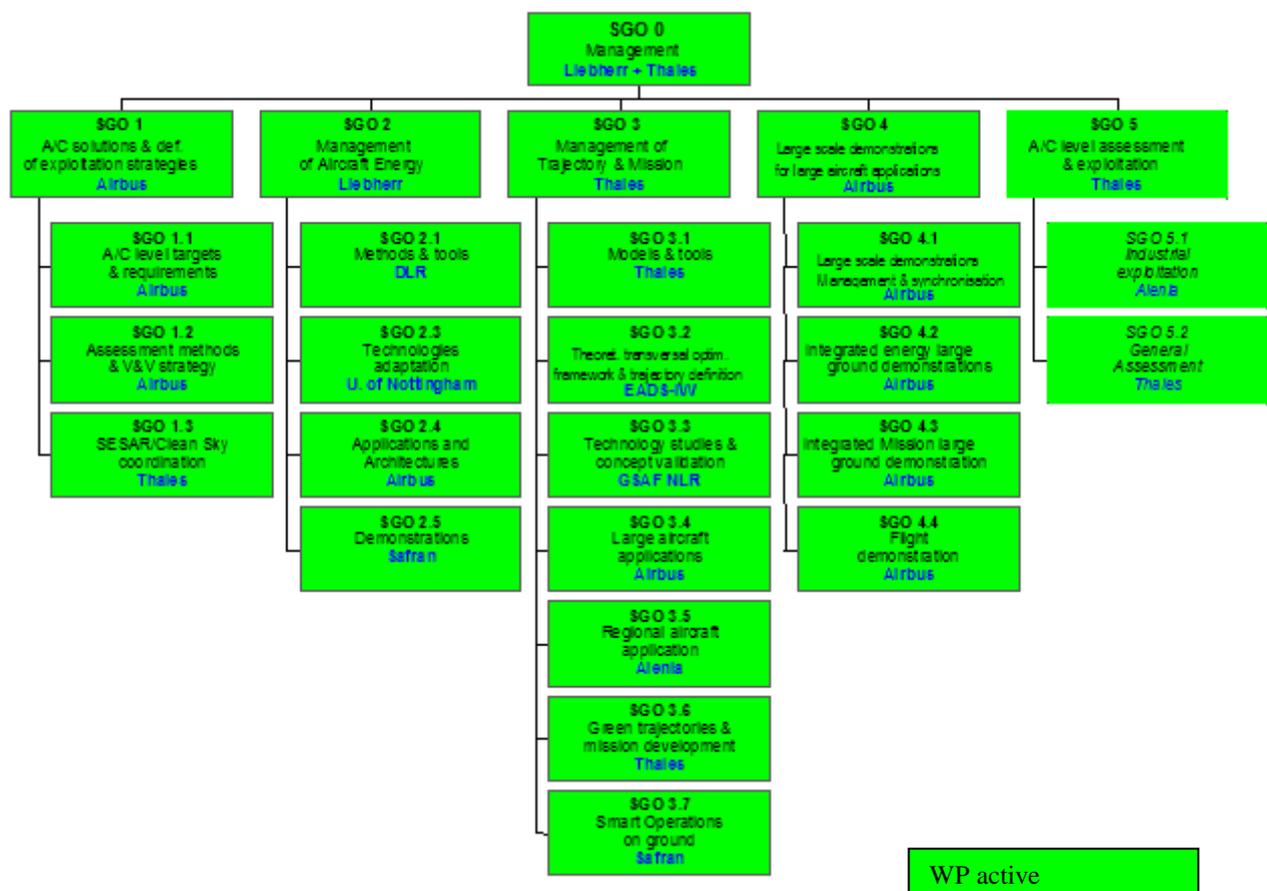


Figure 1 : SGO Work Breakdown Structure

In 2013 SGO has been focussed on achieving progress on all developed technologies to prepare the major demonstrations – both in flight and on ground – which are planned between mid 2014 and 2015. For all technology streams, significant steps forward have been made, as described in each work-package below and positively assessed by the external reviewers, both during the Annual Review in June and in the mid-term meeting end of November.

A significant evolution of the program budget distribution between members was validated, with an increase of budget associated to Ice detection and Electrical Power distribution system, while confirming the technical objectives of these technology threads.

With reference to the annual grant agreement, the currently estimated overall consumption of resources amounts to 98% of the planned value 2013, including the amendment applied during 2013.

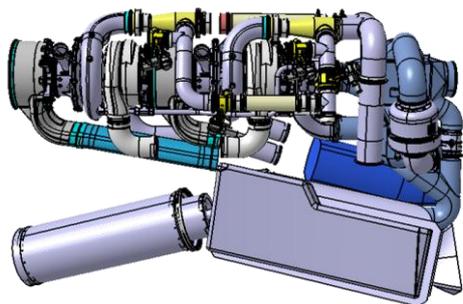
For large aircraft, WP1 has started the update of datapackages and master Validation & Verification plans of both MAE and MTM streams for cycle 2 of SGO. Unfortunately, only the Mission Data-package update could be finalised in 2013. MTM V&V plan is close to completion and entered final review. MAE documents have suffered delays as resources were mobilised on development of cycle 1 technologies. In WP1.3, exchanges with SESAR have been increased in 2013, with a technical workshop held in March where topics of common interest have been reviewed, leading also to further exchange of documents.

In WP2, work on technologies for electrical and thermal energy management has moved on. Throughout 2013, some equipment and systems have been delivered to the various ground test rigs and supported the successful execution of different TRL reviews. However, some developments are behind their schedules and dedicated TRL reviews had to be delayed.

Based on the large aircraft cycle 1 assessment results in 2013, the work on cycle 2 architectures and guidelines has been initiated. In 2012 a workshop on cycle 2 created a list of improvement ideas which should feed into cycle 2 definitions. The follow up of this workshop, foreseen in 2013, did not happen but is now scheduled end of January 2014. Anyway, some ideas on radical electrical architectures, created in 2012, have been more detailed during 2013 and are now to be assessed for implementation into further hardware studies.

The manufacturing of the electrical power centre (EPDC) featuring modular power electronics has been completed and development tests started in the last quarter of 2013. Although partially impacted by late components but thanks to found mitigations, the EPDC can be delivered to PROVEN ground test rig early 2014 for further system testing in relevant aircraft environment carried out in the frame of WP4 test campaign.

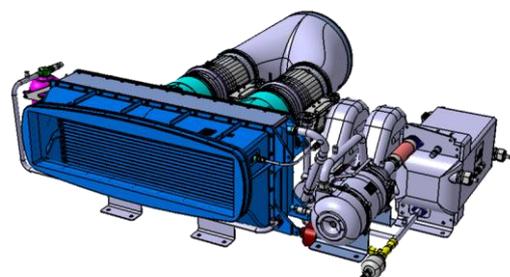
The MAE Wing Ice Protection technology demonstrators for large aircraft have been successfully tested during the IWT ground test campaign in 2012. Based on these results, in 2013 dedicated TRL4 reviews have been held and open actions from these reviews have been completed by end of the year. Now, the preparation of flight test hardware (one electro-thermal and one electro-mechanical solution) has begun. The associated flight test campaign has been shifted to end 2015/ beginning 2016 allowing synchronization with the campaign for Ice Detection and Electrical ECS technologies. The Ice Detection technology also passed the TRL4 milestone successfully mid-2013 and now the flight test prototype is under development.



After the required design adaptation of the electrical ECS Large Aircraft flight test demonstrator in 2012, the mitigation roadmap towards flight test which are now planned at the end of 2015/beginning 2016 has been created and agreed. In 2013, the work on the re-sized flight test hardware (50kW) has begun and in parallel the work on the (original) demonstrator (70kW) which will be used for performance test on ground has moved on.

In the frame of the eECS work for regional aircraft, a flight test preliminary design review has been held mid-2013 and fixed the design as well as the roadmap towards flight test from April 2015.

In the frame of thermal management activities, various challenges had to be tackled. The flight test campaign of the Skin Heat Exchanger, planned at the end of 2013, is delayed to mid of 2014 now due to questions regarding the aircraft operatorship and budget. These issues are now solved and an update of the work plan towards the



flight test campaign is on-going. Nevertheless, the heat exchanger hardware passed successfully the TRL 4 review end of 2013.

The compressor of the vapour cycle system (VCS) needs a partial re-design after performance issues identified during its test campaign in 2013. This will delay the development schedule for this equipment by almost one year, but will not hamper the overall schedule in Clean Sky since the final test means for the VCS, the thermal test rig AVANT, is also not available before 2015. In order to cope with the risk of AVANT availability, a mitigation plan has been defined proposing an alternative, already existing, thermal architecture test rig (GETI), which will be used for VCS testing prior to the AVANT campaign.

Another technology which will be finally tested at the AVANT test rig is the Thermal Management Function. After re-organization of the work package end of 2012, the work on this load management function made good progress in 2013, completed by its successful TRL3 review in December 2013.

In the frame of electrical engine nacelle, the electrical nacelle actuation system has been tested in 2013. Due to technical issues on the test rig, the campaign was stopped and the rig was repaired. Due to this delay, the TRL5 gate of the nacelle actuation system had to be shifted by 7 months to April 2014 after the completion of the test campaign.



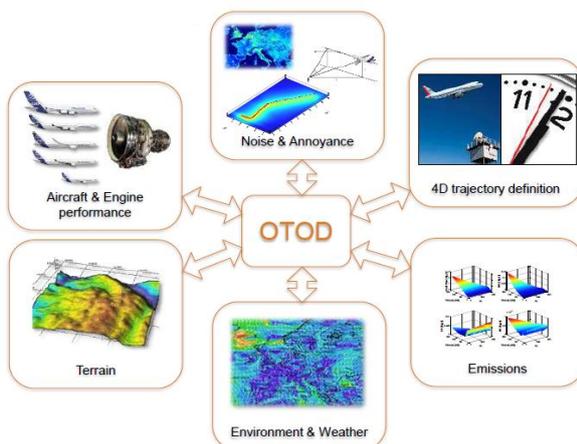
The work on equipment and systems for electrical power generation and distribution progressed well in 2013 and first equipment have been delivered to both large aircraft PROVEN test rig and the other aircraft COPPER Bird test rig. Early 2013 a robust channel, including a permanent magnet generator and induction motors, was delivered to PROVEN for a dedicated WP4 test campaign. Equipment for integration into COPPER Bird i.e. generators, control units, rectifier units and switching components have been delivered in the second half of 2013. Two starter-generators will be delivered beginning of 2014. Some equipment are delayed by half a year but in the most cases sufficient mitigation solutions have been found, not to delay test campaign by more than three months .

An electromechanical actuation system for a helicopter swashplate will be developed in cooperation with GRC ITD. Mid 2013 this system went through a critical design review, held with SGO and GRC participation. The overall system design has been confirmed and now the manufacturing is ongoing. Nonetheless, a risk to meet not the delivery date (beginning 2015) to GRC / Copper Bird test rig and consequently to miss the test slot has been identified. Various mitigation options i.e. another test slot later in 2015 are currently in discussion with GRC and Copper Bird team

At the overall Large Aircraft architecture level studies of the benefits of the more electrical aircraft compared to legacy architecture have progressed. The improvement of specific fuel consumption (SFC) and weight gain associated to the removal of the engine bleed provided by the more electrical aircraft have been assessed. On the other hand the current technology status present in some cases weight, drag penalties as well as SFC impact due mechanical power off-take on the engines by power generators. The quantitative study shows that the more electrical architecture provides fuel benefits on a reference mission. Still the weight of electrical system is identified as a key stake to increase in the future the benefits of the bleedless SGO architecture.

In the field of WP3 – Mission and Trajectory Management (MTM), 2013 has brought major progress towards the main demonstrations planned in 2014 and 15.

Flight management functions have now all passed TRL4 : functions covering the climb (Multi Criteria Departure Procedure), Cruise (Multi Step Cruise) and final approach (Adaptive Increased Glideslope) phases reached TRL4 between September and December 2013. At this stage of validation, new tests cases have been applied to consolidate the estimated environmental gains and the specification of the functions into a



representative FMS architecture has been derived. This allowed to initiate the implementation in the FMS code, which will be pursued in 2014 to lead to the TRL5.

In the field of advanced Weather Radar algorithms, new mock-up have been developed for signal filtering and hazard classification algorithms. Tested on realistic sets of weather scenarios, these algorithms will be included in the AWxR TRL4 planned to be pronounced early 2014 (delayed from Q4 2013)

The prototype implementation of mission optimisation functions have progressed, paving the way to demonstrations in 2014 and TRL5 the following year.

In the field of the Smart Operations on Ground, the TRL4. at system level has been achieved in October 2013 with a few months delay. The roadmap to the system level TRL5 has been clarified.

Using the inputs from SESAR gathered by WP1.3 (OSD level documents), an updated analysis of the SESAR Concept of operation was issued.

The work on major demonstration has accelerated in 2013. On the PROVEN electrical rig, the first ground test campaign has been completed and the second campaign has started with major modifications to the rig in order to accommodate the Electrical Power Distribution System from WP2, which delivery is slightly delayed to 2014. The robust channel has been installed and completely tested on the rig.

Concerning the thermal test rig AVANT, the activity in 2013 has mostly addressed system rig specification and also the elaboration of a mitigation plan as the construction of the test building has finally started after severe delays.

WP4.2.3 has finalised the exploitation of icing wind tunnel test results to issue a test report.

In WP4.2.5, the virtual electrical test activity was kicked off. The test objectives and test platform were defined in collaboration with new partners that have joined SGO via Call for Proposals.

As far as flight tests are concerned, a dedicated project, e-FTD, has been set-up to cover eECS, WIPS and PFIDS activities. This project has passed a key milestone in June 2013: the concept freeze review and is now on a good way towards its Preliminary Design Review planned early 2014.

The preparation of the flight test of the Liquid Skin Heat Exchanger (LSHX) has continued with the signature of the Flight Test Request and the delivery of all design changes for the installation of the LSHX on the test aircraft. Unfortunately due to a slight delay in the qualification of the equipment and some industrial constraints regarding the choice of the aircraft, the test campaign had to be postponed to 2014.

The Dispatch Towing Vehicle has continued its full-scale tests with an A320 and has now terminated the research phase to go for industrialisation.

During 2013, WP5 benefited from the increased maturity of the technologies developed within the other technical work packages from the ITD (WP2 & WP3). In the field of industrial exploitation, the list of topics of common interest in terms of certifications & operations is frozen and two related reports on "More electrical aircraft enabling technologies " and "A/C operations: EFB impact on airline/crew operations" have been issued. However, the lack of skilled resources to further work on certification is still accurate and must be carefully monitored. Challenging thematics were studied in the area of the impact on the Design Standard. Three reports have been issued on Power quality, Cooling Fluids and Modeling and Simulation of Power Systems. In the field of industrial exploitation, two common topics, have been selected : magnetic and electronic (switch) parts.

In the area of the General Assessment, the first assessment of the progress in terms of environmental benefits & maturity (TRL level) provided by all the SGO technologies has progressed, but the official release of the document has been postponed to Q1 2014 to take into account all the data provided by TRL gates for a number of relevant technologies, which were achieved in Q4 2013. Interface with SFWA has matured : the exhaustive list of all technologies to be integrated in SFWA is closed and the detailed schedule of SGO deliveries to SFWA is now synchronized with the deliveries of SFWA to the TE.