Clean Sky is the most ambitious aeronautical research program ever launched in Europe. Its mission is to develop breakthrough technologies to significantly increase the environmental performances of airplanes and air transport, resulting in less noisy and more fuel efficient aircraft, hence bringing a key contribution in achieving the Single European Sky environmental objectives.

The Clean Sky JTI (Joint Technology Initiative) was born in 2008 and represents a unique Public-Private Partnership between the European Commission and the industry. It is managed by the Clean Sky Joint Undertaking (CSJU) until 31 December 2017.

The CSJU will deliver demonstrators in all segments of civil air transport, grouped into six technological areas called 'Integrated Technology Demonstrators' (ITD).

ITD Leaders

Each ITD is led by two industry leaders that are committed for the full duration of the CSJU. They are the founding members (with the European Union) of the CSJU.

EADS AIRBUS EUROCOPTER
Fraunhofer AleniaAermacchi AgustaWestland
SAFRAN THALES SAAB
DASSAULT AVIATION LIEBHERR Rolls-Royce

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CLEANSKY

Clean Sky JTI (Joint Technology Initiative)
http://www.cleansky.eu

European Commission
http://ec.europa.eu

GENIAL Project Workshop

IDS INGEGNERIA DEI SISTEMI
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September 24th, 2013 – 02.00 p.m.

The GENIAL Project

The Problem

The metallic bodies of “standard” aircrafts are commonly used as conductive electrical pathways for the return of direct and alternating currents, fault currents, lightning currents and also have other functions related to voltage differentials, electrostatic charge draining, electromagnetic shielding etc.

This is no longer applicable on aircraft made of composite materials because of the low conductivity and thermal sensitivity that characterize these materials. A dedicated conductive electrical pathway, i.e. the so called “Current Return Network (CRN), or Electrical Structural Network (ESN), or ALmost Equipotential Electrical Network (ALEEN)”, therefore has to be integrated into the aircraft body.

Such networks can be practically realized in several different ways, exploiting both structural metallic parts of the aircraft (beams, seat rails, etc.) and also dedicated paths, but in any case they can never be an ideal ground, and poorer performance than that currently obtained on metal aircraft may be expected.

Aeronautical manufacturers and providers of cable-harness and equipment are interested in having an accurate electrical/electromagnetic characterization of ALEEN configurations, in order to be able to correctly design the connected/co-located electrical systems such as EWIS (Electrical Wiring Interconnection System),and optimize ALEEN without needing expensive (and often practically unfeasible) repeated bread boarding, reducing risks and saving mass.

The Project

A numerical method and a CAE (Computer Aided Engineering) tool to model the current return networks installed aboard composite aircrafts have been developed and validated in the frame of **GENIAL (optimizinG Electrical Network In AirpLane composite structures)** project.

The implementing team of Genial was composed of Ingegneria Dei Sistemi S.p.A. (IDS) and the University of L’Aquila (UNIVAQ), collaborating with the ITD Topic Manager Safran Engineering Services (SEngS).

URL: http://genialproject.univaq.it

Program

14:00-14:15	*Opening remarks – Scope of the Workshop* **Aldo Bonsignore (IDS)**
14:15-14:45	Introduction to the Genial Project: optimizinG Electrical Network In AirpLane composite structure **Anca Goleanu (Labinal/SEnS)**
14:45-15:00	Challenges of the Genial Project **Mauro Bandinelli (IDS)**
15:00-15:30	ALEEN - ALmost Equipotential Electrical Network Modelling Tool description **Mauro Bandinelli (IDS)**
15:30-16:00	The Partial Element Equivalent Circuit Method for the Analysis of Composite Airplanes **Giulio Antonini (UNIVAQ)**
16:00-16:30	*Coffee Break*
16:30-17:00	GENIAL Performance – Validation test results **Alessandro Mori (IDS)**
17:00-17:15	GENIAL further development **Mauro Bandinelli (IDS)**
17:15-17:30	*Final discussion*

ALEEN modeling

Modeling Tool

The E-MIND electromagnetic CAE Tool (http://www.idscorporation.com/images/aeronautical/homepage/BRO_AERO_EMIND.pdf) has been updated with a new procedure dedicated to ALEENs modeling. The Tool is able:

- to input aircraft and ALEEN geometries and material properties from CAD (e.g. CATIA)
- to evaluate the equivalent impedance matrix at ALEEN terminals in the frequency range DC-MHz’s, also considering the EWIS and the electromagnetic interaction with aircraft body
- to visualize induced current and voltage distribution on the aircraft/ALEEN.

Methods

A 3D full-wave modeling procedure based on the S-PEEC (Surface - Partial Element Equivalent Circuit) has been developed. The already available MR-MoM (MultiResolution – Method of Moment) algorithm has been also integrated. Both have special “**low-frequency stability**” and “**high-fidelity modeling**” features.

No “a-priori simplifications” of the geometry (which moreover are scarcely manageable to obtain accurate results in wide band analyses) are required to reduce the condition number. **DC resistance**, **skin-effect**, **inductive and capacitive effects** are represented. Modeling of **composites** through physical and equivalent parameters and modeling of **bonding resistances** are allowed.

An **acceleration method** based on ACA algorithm (Adaptive Cross-Approximation) and **parallel coding** have been applied to allow effective analysis of large structures in a limited amount of time, with currently available HW resources (i.e. no expensive HPC resources are required).

Validated

The numerical models and the Tool have been validated by comparing simulation results with data measured by SAFRAN-Labinal on an ALEEN mock-up.