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IPAS Installed Performance of Antennas on AeroStructures

Specifically Targeted Research Project

Priority 4: Aeronautics and Space

FINAL PUBLISHABLE REPORT

Start date of project: 1st November 2003 Duration: 39 months

Prepared by BAE SYSTEMS

Executive Summary

Projective objectives:

The purpose of the IPAS (Installed performance of antennas on aerostructures) research programme is to improve computer aided engineering design and evaluation capabilities (computational and measurement methods) for the installed performance of antennas on aircraft structures. These improved capabilities will help reduce the time and cost for positioning and installing antennas on aircraft. It will lead to improved prediction of interoperability and performance of antennas, with consequent contributions to operational safety and to the quality of on-board services.

The main aims of the IPAS Project are to:

- define procedures for accurately predicting the installed performance of real antennas,
- investigate the effect of non-metallic materials on the performance of antennas,
- develop methods to help bridging the computational frequency gap,
- verification of computational tools,
- improvements in coupling calculations and the investigation of the feasibility of an airborne near field test facility for full scale measurements on aircraft.
- Validate and verify of computational tools and methods on canonical bodies, scaled aircraft and full-scaled airframes. This involves:
    - software from different partners and measurement-to-code comparison using experimental data from the test sites of different partners.

IPAS successes and achievements:

The final success and achievements of the IPAS project can be briefly stated in two ways; firstly the successes and achievements of the modelling aspects of the project and secondly the successes and achievements of the measurement program.

Modelling:

IPAS has achieved its primary gaol of extending our ability to accurately predict installed antenna performance. In particular, the accuracy, the range of applicability and the ease of use of computer modelling have been improved to the extent that numerical modelling has overtaken scale model measurements as the most effective prediction and qualification approach over a wide range of frequencies.

A key to success in cost-effective numerical modelling is to get a model that eliminates unwanted detail but captures the essential physics. IPAS has made significant contributions here: Improved CAD-to-mesh software has helped get good vehicle models. Development of simplified antenna models combined with calibration measurements has made accurate simulation of gain and coupling of quite complicated production antennas on full aircraft feasible. Improvements in multidomain and fast solver methods have extended the range of frequencies accessible to numerical modelling.

The validation of method-of-moment (MoM), fast multipole (FMM) and multi-domain (MD) software against measurements for antennas on canonical body, on scale model and on full-scale aircraft has demonstrated electromagnetic software is now sufficiently mature to replace scale models as the tool of

choice for installed performance assessment. Improved meshing and knowledge captured from the validation work has made the software accessible as everyday engineering design tools.

Measurement programme:

The qualification and certification process is accomplished by mock-up and in-flight measurements on a real aircraft with coupling and radiation patterns. In IPAS, the prediction of computer models have been compared with measurements performed under known and real conditions. IPAS achieved the measurement part while proposing bases model for comparison with codes. Several measurement parameters have been identified as being affecting results and need to be taken into account for the calculation code improvement.

In order to bring bases model for comparison, measurements on both mock-up and full-scaled model have been performed.

Three aircraft families (ATR42, Fokker100 and IPAS-1) have been necessary to demonstrate the reliability of the code prediction with mock-up models in chamber and in free space conditions. The measurements carried out on scale models have shown that in general there is a good agreement between the measurement results for the different antenna test ranges (far-field out-door, near-field in-door, compact range) on one hand and between the measurement results and the computations on the other hand.

Tests on full-scale model have been essentially done on ATR72. Ground tests have been a first approach in the process. Conclusions done after this first step have permitted to elaborate a dedicated scenario exclusive for the IPAS project with in-flight measurement on an ATR72. This kind of test had never been done in the frame of the air transport civil aeronautic. Nevertheless, all the measurements on the ground and in flight will allow a comparison more realistic of the behaviour of the antennas on a structure aircraft.

The aim of IPAS was to establish the reliability and accuracy of computational electromagnetic tools, by a validation process involving code-to-code comparison and code-to-measurement comparison has been achieved; this has been achieved. Global results are now sufficient to propose computation methods to the authorities for a certification process.

Exploitation:

In addition to the technical successes of the project a broad ranging exploitation plan was defined. The key exploitation aspects are as follows:

- IPAS website – A website was set comprising two parts. A ‘consortium restricted’ part enabled the exchange of technical information between members and a public section acted as a shop window of IPAS activities.

- Dissemination of results to other European projects. An example of this is the ANASTASIA project which employed IPAS results in the areas of asymptotic modelling, FEM simulation and geometry preparation.

- Dissemination to civil aviation authorities. Numerous presentations were made to the French civil aviation authorities (DGAC). As a direct result of IPAS activities the DGAC is now in the process of accepting numerical modelling as a means of certifying aircraft antenna layouts.

- Within the exploitation plan many of the partners wrote technical papers that were either presented at conferences or published in technical journals; in total over 30 papers were published and as many public talks were presented.

The IPAS project has now drawn to a successful conclusion; all the objectives have been achieved for the mutual benefit of the consortium partners and the European aerospace industries.