TAUPE Publishable **Summary**

Description and main objectives of the project

TAUPE is a FP7 collaborative research project led by SAFRAN Engineering Services aiming at reducing the length and mass of the aircraft cabling by:

- Defining a fully-optimized avionic architecture on specific systems, mixing the aircraft power and communication networks.
- Introducing inside the aircraft:
    1. PLC technology (PowerLine Communication)
    2. PoD technology (Power over Data)

Both technologies essentially aim to **supply power and data over the same cable (**Figure 1**)**.

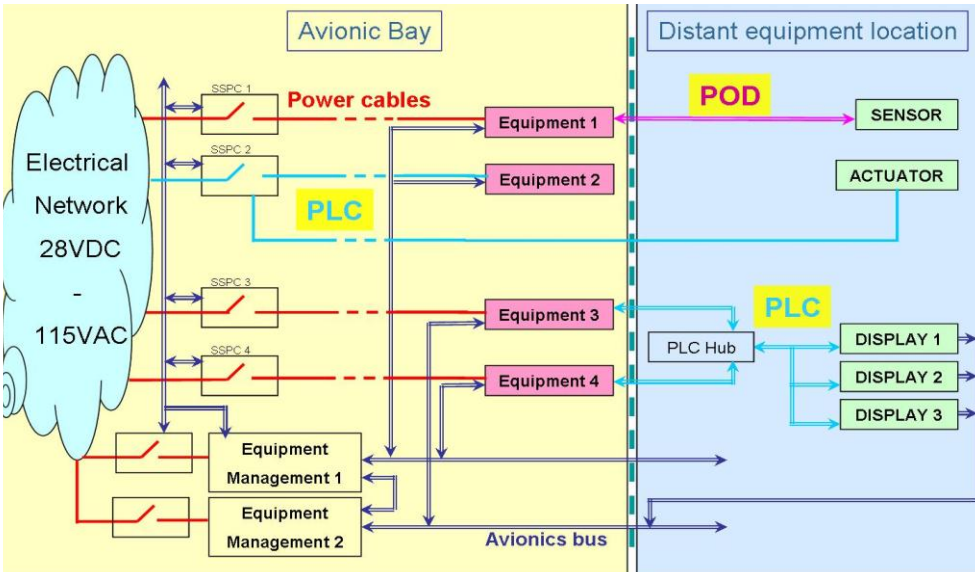

Figure 1. Example of TAUPE architecture.

Fully in line with **ACARE Strategic Research Agenda**, TAUPE will deliver:

- Specifications for harness wiring and network equipment
- Requirements for systems qualification

These main results will allow system weight reduction, easy and cost-effective installation, retrofit and maintenance.

Figure 2. TAUPE partners.

17 partners from 6 European countries are involved in the TAUPE project (Figure 2). The project is divided into 8 Work Packages (WP): (5 Research Technology Development (RTD) WPs; 1 Dissemination WP; 1 Exploitation WP; and 1 Management WP):

WP1: Requirements and PLC/PoD optimised architecture (Leader: Airbus Operations)

- To identify electrical and communication networks for the next generation of carbon fuselage aircraft and, for existing aircraft, for retrofit purposes
- To define generic aircraft architecture principles using PLC & PoD
- To validate the generic aircraft architecture on a basis of a set of criteria using defined relevant applications (the reference applications)
- To specify the requirements for the reference applications used to validate the feasibility of the concept, to identify the critical demonstration elements and to define the verification & validation strategy

WP2: Networks Definition and Simulation (Leader: LABINAL/SAFRAN Engineering Services)

- To provide a channel model enabling applications classification for PLC & PoD.
- To provide a simulation tool to predict the feasibility and performance of PLC & PoD communications in terms of range, data rate and bit error rate.
- To provide physical architectures that are compliant with WP1 and that permit the Validation task to be carried out.
- To provide Electro-Magnetic Compatibility (EMC) and electronic constraints on equipment due to the modem integration.

WP3: Mock-Up components design and adaptation (Leader: EADS Innovation Works)

- To adapt the wiring networks of the benches to be used so that they will be compliant with WP4 integration and WP5 functional validation tests.

- To adapt current PLC solutions to EMC and transmission objectives taking into account aeronautical standards (RTCA DO160, DO178 and DO254 mainly) and to provide recommendations for future more adapted chipsets.
- To provide interfaces between reference aircraft applications and the PLC modem targeting mock-up integration.

WP4: Mock-Up Integration (Leader: Hochschule Luzern)

- To provide components needed for PLC & PoD subsystem integration.
- To provide the bridges necessary to its implementation into the mock-up systems.
- To integrate the PLC modem subsystem and the interface adaptation modules developed in WP3 with equipment of the different reference applications.

WP5: Verification and Validation tests (Leader: NLR)

- To provide the Verification & Validation (V&V) test plan, taking into account certification, safety issues, the functionalities and capabilities of the reference applications in order to guarantee a reliable assessment.
- To ensure validation of all mock-up/test-bench applications (developed in WP4) in the associated test benches.

WP6: Dissemination (Leader: LABINAL/SAFRAN Engineering Services)

- To provide the TAUPE dissemination material (TAUPE public web site and documentation).
- To organise two public events to widely disseminate the results and insights available.

WP7: Exploitation (Leader: LABINAL/SAFRAN Engineering Services)

- To ensure the exploitation of the TAUPE results by collaboration with the JTI CLEAN SKY
- To manage the TAUPE Intellectual Property Rights.

WP0: Project Management (Leader: LABINAL/SAFRAN Engineering Services)

- To set up and maintain the management infrastructure
- To provide technical coordination of the project partners
- To provide financial and contractual management of the consortium, especially regarding the European Commission expectancies

The targeted overall achievements of TAUPE are:

- Weight reduction
- Easy and cost-effective installation and possibly retrofit
- Cost-effective maintenance

Main Results

TAUPE has defined a fully optimised avionic architecture for power and data transmission on unique path wires, mixing the aircraft power and communication networks. It has introduced two technologies inside the aircraft: PLC (Power Line Communication) and PoD (Power over data) aiming to supply power and data over the same cable and produced two system Mock-ups to demonstrate these technologies. The outcome of TAUPE project in terms of cable saving potential is a weight reduction of 359 kg and 36km less cable for an A380 aircraft. The potential fuel savings on a single A320 aircraft would amount to 36 000 $/year, a substantial economic and environmental benefit. The main results achieved during the project included:

On the RTD side:

- **WP1** has provided the architecture and requirements needed by the other WPs.
- **WP2** was able to provide a validated set of optimised networks architecture and the software tools for the PLC & PoD communications simulation. It also provided the Equipment EMC & Safety constraints and the aircraft Systems classification for the PLC & PoD transmissions.
- **WP3** was able to adapt the wiring networks of the Cabin Mock-Up and the Cockpit Display System (CDS) A380 system bench to be compliant with WP4 integration and WP5 functional validation tests for the reference applications. WP3, as planned, provided the interfaces between reference aircraft applications and the PLC modem targeting mock-up integration. It adapted PLC solutions to EMC and transmission objectives taking into account aeronautical standards (RTCA DO160, DO178 and DO254) and to provide recommendations for future more adapted chipsets.
- **WP4** has integrated the PLC & PoD subsystem and applications equipment (Figure 3, Figure 4). The final version of the PLC coupling modules were manufactured and delivered along with the PLC modems. The physical integration of the PLC demonstrator was successfully completed at EADS-IW as was the integration testing of the PLC subsystem. The Safety assessment of PLC & PoD systems was completed.
- **WP5** provided a V&V test plan, completed Verification & Validation testing on the Cabin Mock-up and the CDS A380 system bench and was able to provide a statement on the project's targeted achievements. No showstoppers were identified during the V&V process or safety analysis and concrete weight/cost savings could be calculated. For example, considering an A320 aircraft, the potential fuel savings obtained by using PLC technology would reach 36 000 $/year. In addition, PLC technology will enable 1/3 less cable quantity which is simplifying cabling routing and installation, maintainability and retrofit. TRL4 is reached, with some aspect of the TAUPE project nearly at TRL5.

On the Management side:

The successful implementation of the management structure lasted until the end of the project. Associated tools (indicators, templates, process and procedures) delivered at project Kick Off meeting were effectively used to monitor project progress and to implement pro-active correction actions when necessary. Thanks to the project collaborative website, partners can easily access project documentation and maintain their awareness on project progress. Management team was also particularly mobilised for the contractual implementation of contingency plans proposed by Management Committee and approved by Steering Committee. This included amendments of Grant

Agreement and Consortium Agreement with budget reallocation to take into account the shift/extra activities agreed between and within partners.

On Dissemination and Exploitation side:

The TAUPE public website (www.taupe-project.eu) was maintained and regularly updated to be fully operational and up to date. In addition, major achievements have been disseminated through partners' public activities (presentations and publications). The M18 and the M42 TAUPE public dissemination event were successfully operated, gathering worldwide audience. During these events, presentations were made by the partners that covered all topics dealt with within the project and achievements. It was agreed during the closing round-table session at the M42 TAUPE public dissemination event that the TAUPE exploitable technology is promising and a follow-up project with the ambition to take the technology to TRL 6-7 is desirable.

Figure 3. Cabin Mock-Up (PLC Demonstrator).

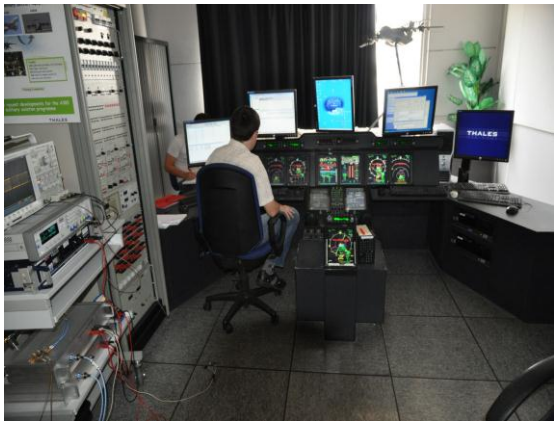

Figure 4. Cock-Pit Mock-Up (PoD Demonstrator).

Expected final results and their potential impacts and use

This project has been conducted in line with **ACARE Strategic Research Agenda 2** (High Level Target Concept "The Highly Cost Efficient Air Transport System") and in particular in line with the activities envisaged in the frame of the System for green operations.

TAUPE has participated to enable the "Cost effective" aircraft by providing innovative responses to aircraft challenges, such as solutions to **reduce wiring on board**, in order to save weight & cost. This research will allow reduction of a large number of connections and tests in the final assembly line of future aircraft, the simplification of system design architectures and smart maintenance. This has positive impact on safety, cost and time issues.

TAUPE partners have been committed to widely disseminating the technical assessment of the project to suppliers, SMEs, Academics and Research centres. TAUPE has organised 2 dedicated public dissemination events to present the main project results and technology benefits to the aeronautics and space industry (including SMEs), academia and research centres, and gathering 150 attendees from Europe and North America. The TAUPE public website www.taupe-project.eu has also contributed to the wide dissemination of the TAUPE results. In addition, the academic partners involved in TAUPE have published frequently in peer-reviewed journals with international scope.

Both academic and industrial TAUPE partners have also actively participated in conferences and workshops relevant for TAUPE purposes. These network activities have been important to avoid duplication of research activities and to raise awareness about PoD and PLC technologies evolution.

The project has supported competitiveness of European industries in the global market by guaranteeing safety (design robustness able to meet certification requirements), industrialisation as well as the related costs and portability to other equipment.

TAUPE has provided benefits to citizens, society and climate, considering the potential weight reduction on aircraft. The results show a **measurable potential reduction of fuel consumption, as well as CO_2 and NOx emissions.** The cost effective capacity also demonstrated with impact on aircraft life cycle and operating costs will allow fleets to become greener and airlines to develop a more competitive pricing for air travel.