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Technik & Architektur
CC Innovation in Intelligent
Multimedia Sensor Networks

Innovation in Intelligent Multimedia Sensor Networks

PROJECT

TAUPE

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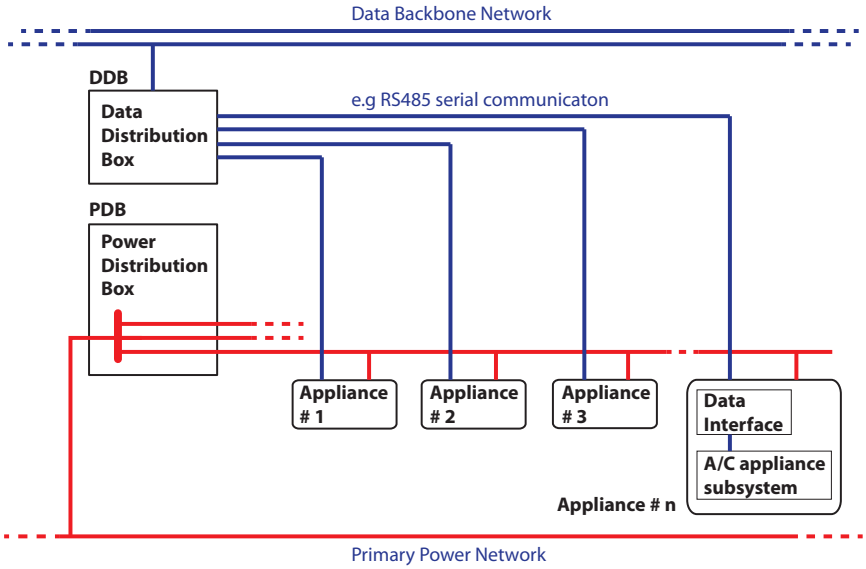
Transmission in Aircraft on Unique Path wirEs

The TAUPE project is a collaborative research project co–funded by the European Commission in the Seventh Framework Programme (FP7). It addresses the aeronautics sector and is constituted by 16 partners coming from 6 different European countries.

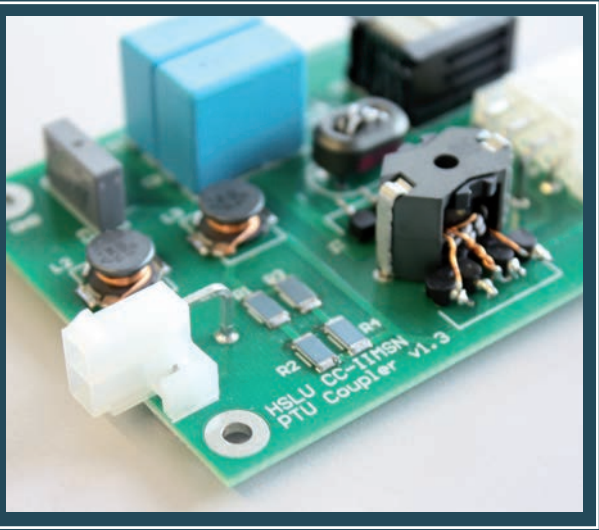
Based on results obtained from, among other sources, the European Union (EU) Power Optimized Aircraft (POA) project, electrical systems are replacing conventional hydraulic and pneumatic systems in order to develop the More Electric Aircraft (MEA) or even All Electric Aircraft (AEA). The disadvantage of MEA/AEA is that the transfer to electrical systems will result in significantly more wires leading to considerable weight, complexity and space allocation increases. Cabling is one of the major challenges in developing and maintaining current as well as future aircraft (A/C). Already today several hundreds of kilometers of cabling are installed in a single A/C.

One of the possible solutions to mitigating the increase in wires is to integrate separate power and data distribution networks into a single network providing both data and power transmission. The results of the TAUPE project have provided a fully optimized avionic architecture for power and data transmission on unique path wires. Two such solutions were investigated using either Powerline Communications (PLC) in order to enable data transmission over the power distribution network or Power over Data (PoD) in order to transmit power over data cabling.

The PLC solution was developed considering two different reference applications: the Cabin Lighting System (CLS) and the Cabin Communication System (CCS). These applications were selected as they are representative both in terms of data traffic as well as wiring harness complexity for a wider variety of non-flight critical avionics systems. The development of the PLC solution has been aided through extensive numerical simulations of propagation channel characteristics, measurements on a test bench representative of an A/C wiring harness and integration into



Conventional approach for power and data transmission in an aircraft



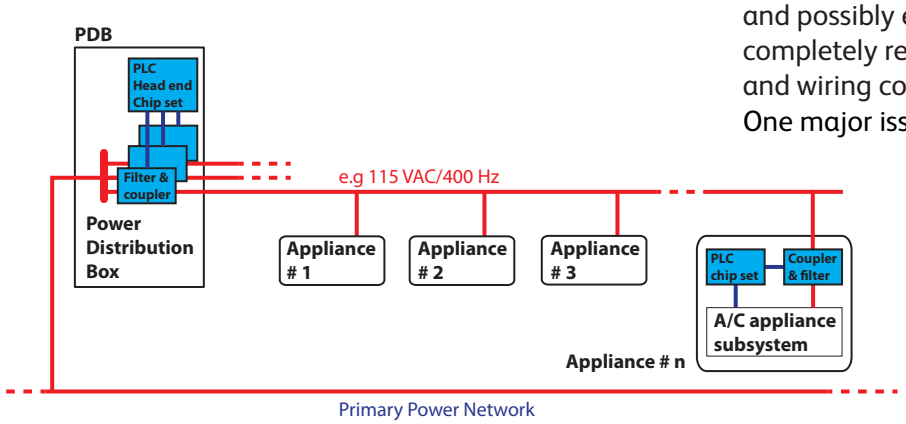
a full-scale demonstrator (Cabin Mock-up at EADS-Innovation Works in Ottobrunn, Germany).

CC-IIMSN has played a crucial role within this project by supporting the requirements definition, design of an optimized PLC architecture, development of the PLC modem firmware and PLC line coupling modules as well as assisting in verification & validation testing including Electromagnetic Compatibility (EMC) measurements. Also collaborating with HSLU in the TAUPE project were leaders in the aeronautics industry such as Airbus, Diehl Aerospace, EADS, NLR and Thales Avionics.

The conventional approach used in A/C systems is to provide power and data distribution on separate networks. This means that each application equipment must provide two separate interfaces in order to access each respective network. In a PLC approach, dedicated wiring for data transmission may be completely removed and the necessary additional modem, coupling and filtering components can be integrated directly into the application equipment resulting in a solution providing a single interface for power and data. Furthermore, an optimized PLC architecture takes advantage of the multi-tiered or branched nature of the power distribution network in order to increase the reusability of the limited PLC bandwidth using a cellular approach.

Technologies and standards for PLC are in a very mature state for in-home applications; however their use in A/C has only received minimal attention. While these standards may principally be applied in aeronautics applications their adaptation for use in an A/C is unfortunately not straightforward. An A/C PLC solution may suffer from a number of drawbacks including an adverse propagation channel, noise and EMC compliance as the PLC technology operates in a frequency band (2-30MHz) which is seen as unwanted RF emissions regarding EMC. However, the advantage of this approach is that dedicated wiring and possibly equipment for data transmission may be completely removed thus providing reduced weight and wiring complexity.

One major issue of using airborne power distribution networks for data communications is related to their single wire (monofilar) structure with a common chassis ground return path. Such networks appear unfavorable for PLC in regards to the asymmetric transmission line structure with relatively high wire-to-chassis distance, undefined

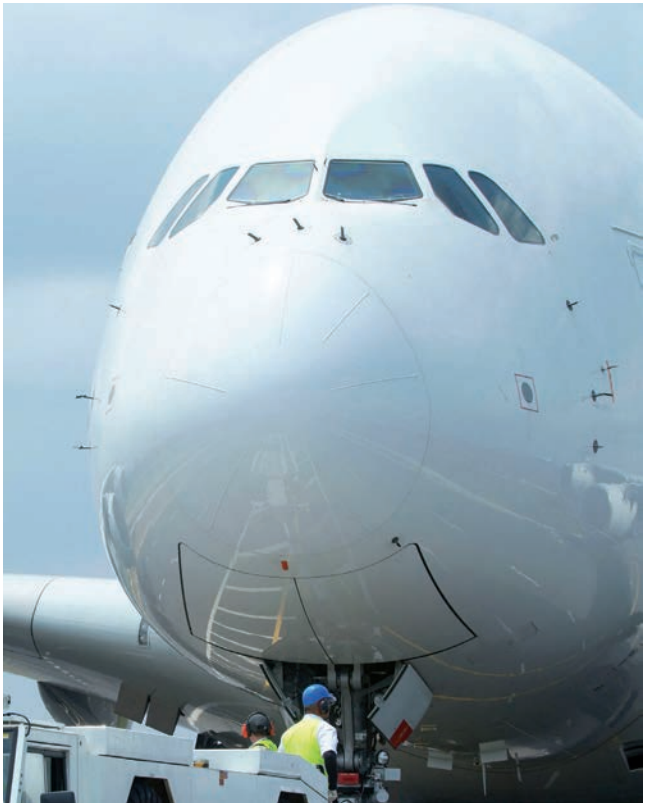


PLC approach for power and data transmission in an aircraft

characteristic impedance, low noise cross talk attenuation in wire bundles and regarding conducted and radiated emissions and
susceptibility of RF radiated fields as defined by existing aeronautical EMC standards such as the EUROCAE ED-14 / RTCA DO-160).

An alternative approach has, therefore, been developed that replaces the single wire by a double wire (bifilar approach), providing a homogenous and well defined symmetric transmission line (differential mode - DM) for data, but maintaining the asymmetric mode with a common ground return path for the distribution of power (common mode - CM). It has been shown that this solution improves the performance of a PLC-based data network dramatically and is also one of the keys to achieving compliance with existing EMC norms. Furthermore, the inherent redundancy of the double wire enables a means to detect almost any kind of wire faults including arc faults; even those that may not be reliably detectable in a conventional single wire power distribution system. These benefits can outweigh the drawbacks of the required double wire cabling[1].
Within the TAUPE project, the PLC approach has been developed to the Technology Readiness Level (TRL) 4 through the development of a demonstrator with over forty PLC-enabled avionics equipment. Extensive system level functional and performance testing as well as unit level EMC testing have
successfully proven the feasibility of PLC for non-critical avionics applications.
More information can be found in the official project dissemination presentation and under the official project website

http://www.taupe-project.eu



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[1] S. Dominiak, H. Widmer, M. Bittner and U. Dersch, "A Bifilar Approach to Power and Data Transmission over Common Wires in Aircraft," *Digital Avionics Systems Conference (DASC), 2011 IEEE/AIAA 30th, Oct. 2011.*

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