DAPHNE
Developing aircraft photonic networks
Newsletter #1 Feb-10

Welcome to the first DAPHNE newsletter!

DAPHNE is a project supported by the European Commission's Seventh Framework Programme to develop photonic networks and components for aircraft. The core of the project is to exploit photonic technology from terrestrial communications networks and to identify and address technology gaps in implementing photonics extensively throughout the aircraft industry. The project brings together avionic equipment and aircraft manufacturers with photonic industry members and academic network specialists.

- DAPHNE started in Sep-09 and will run for three years
- The project has thirteen partners from seven nations
- Balance of academic & research organisations with large & small industrial partners
- Project lead organisation: Airbus.

This is the first of six newsletters to disseminate the objectives and results of the project. More information may be found on the project website (www.fp7daphne.eu) which is kept up-to-date with all the latest news, and has links to related technology and events. This newsletter is intended to provoke interest: please contact us if you have further questions: contact emails are given at the foot of the page.

Contents

Consortium

EADS, DTU, Gooch & Housego Group, Selex Galileo, Airbus, GMV Innovating Solutions, BAE Systems, Ilmenau University of Technology, INESC Porto Laboratório Associado, SQS Vláknová Optika, AgustaWestland A Finmeccanica Company, Vivid Components, D-Lightsys

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SEVENTH FRAMEWORK PROGRAMME

Introduction to DAPHNE

DAPHNE objectives

Objectives: DAPHNE aims to increase the use of telecoms and industrial optical networking technology in future European aircraft and systems. Fibre optics and photonics offers obvious size, weight and bit rate advantages beyond aircraft systems state-of-the-art, but there are several other benefits:

- Excellent electromagnetic compatibility (EMC) due to the nature of the optical signal, without the need for heavy and bulky shielding
- Increased functionality, *e.g.* wavelength division multiplexing (WDM), wavelength switching and optical-electrical-optical (OEO) conversion, potentially permit aircraft networks to be modular and reconfigurable
- Hierarchical segregation: *e.g.* physical (multiple fibre), wavelength (single fibre) or temporal (single channel) allows novel modular network designs.

Instead of many discrete systems each with its own infrastructure, photonics allows a single network that delivers a “signal transport function” capable of supporting the channel segregation needs associated with different Design Assurance Levels (DALs, *i.e.* different levels of criticality) with the required quality-of-service characteristics of the channel.

Appropriate use of fibre optics could greatly reduce the amount of cable used in aircraft networks

DAPHNE challenges

The increased functionality and data transmission speeds on modern aircraft make the investment in aircraft optical communications cost-effective, as copper-based systems become increasingly heavy and expensive. However, aircraft networks differ from terrestrial telecoms systems and other optical networks (*e.g.* rail, automotive) in several fundamental respects:

- Network size: there are far fewer nodes on aircraft than on typical telecoms networks (thousands rather than millions) and much shorter link lengths: (metres rather than kilometres). This radically changes the cost model and optimised network design.
- Traffic type: The system must cope with signals ranging from sub-kbps to multi-Gbps using avionic protocols, some of which are not directly fibre-compatible
- Component limitations: Aircraft systems demand extended performance but also wider operating temperature range, demanding shock & vibration, rigorous flame & toxicity specifications *etc.*
- Component standards: pre-requisite for component qualification in many aircraft manufacturers is certification to an appropriate international standard.

DAPHNE aims to tackle these problems to facilitate the use of photonics within the aeronautic industry and establish the basis for a common infrastructure for aircraft photonic networks.

DAPHNE Advisory Group

The DAPHNE consortium consists of a small group of leading technical companies, but if the project results are to be taken up by industry, a much wider cross-section of industry will need to be aware of the project aims, progress and results. Consequently, a number of organisations will be invited to form an external group of advisors to the project; this is the DAPHNE Advisory Group (DAG). The DAG has three main aims:

- Bring technical inputs from a wider industrial group, and help to fully define the initial project requirements
- Receive periodic updates on the project direction and technical progress and to interact with the DAPHNE consortium to provide comments from a wider industrial perspective
- Enable the recommendations to be supported by a "critical mass" and to promote further uptake of the project results.

The DAG will meet on a bi-annual basis. Meetings will be split into groups by technology area, with each sub-group consisting of manufacturers of:

- Components
- Cables and fibre
- Avionics modules
- Aircraft

The DAG will be open to any organisation willing to contribute to the project. If you are interested in finding out more, please contact:

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Consortium overview

UK
GOOCH & HOUSEGO GROUP
BAE SYSTEMS
AgustaWestland A Finmeccanica Company

DENMARK
DTU

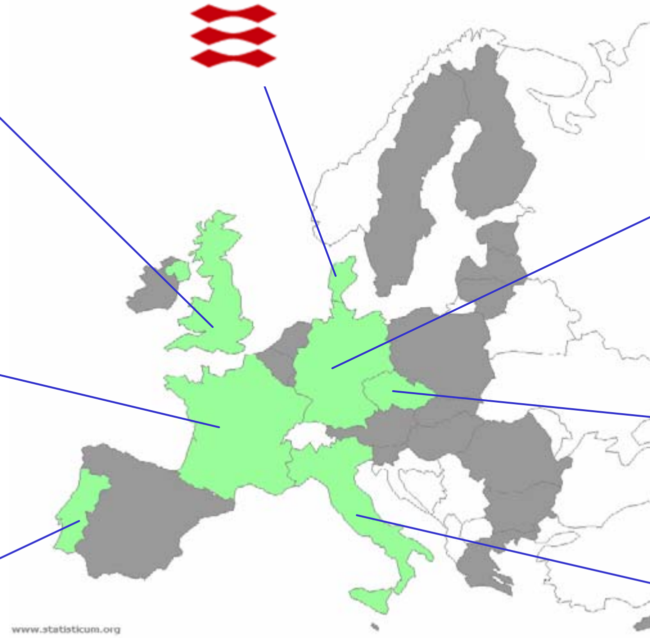
GERMANY
ILMENAU UNIVERSITY OF TECHNOLOGY
AIRBUS
EADS
VIVID COMPONENTS

FRANCE
D-Lightsys

CZECH REPUBLIC
SQS VLÁKNOVÁ OPTIKA

PORTUGAL
gmv INNOVATING SOLUTIONS
INESCPORTO

ITALY
SELEX GALILEO



•13 partners; 7 nations

• Project lead organisation: Airbus Deutschland.

DAPHNE scope

This DAPHNE objectives will be tackled at four levels:

- Networks — Adapt optical network technology for aircraft platforms
- Modules — Define a modular infrastructure for aircraft fibre optic networks
- Components — Develop photonic component technology for aircraft environments
- Dissemination — Disseminate project results to aircraft industry to ensure effective uptake

Networks

A wide range of fibre optic network topologies and techniques has been developed for terrestrial systems: these will be analysed, adapted and optimised for representative aircraft platforms (large & small aircraft; rotary & fixed wing).

Extended network functional and environmental testing under aircraft operating conditions will be carried out to verify network performance including critical system safety testing that analyses reliability and failure modes.

Modules

DAPHNE will define a scalable, modular infrastructure for aircraft photonic networks including node and interconnect concepts. In general, standard avionic boxes and interfaces were designed for electronic equipment, but are not optimised for photonics; a new avionic box standard will be promoted. A modular building block system suitable for aircraft environments will be developed. Standard practices for optical signal management from circuit board level to the external connector interface will be defined.

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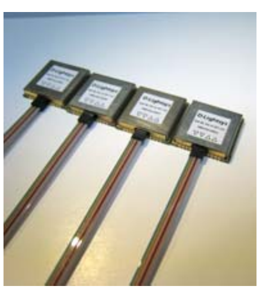
Components



Key devices and components for the DAPHNE infrastructure require adaptation to make them suitable for use in aircraft operational environments. Detailed requirements will follow from the baseline studies but are likely to include: ruggedisation for aircraft environments, compact intra-module connectors, full duplex MM fibre-optic transceivers and single and multiple ribbon fibre break-out. Standardised interfaces, *i.e.* a well-defined mating point interface between component and network, would greatly improve the compatibility of components from different manufacturers without needing to specify the connector itself.

Dissemination

The uptake of the results by industry is essential to the project success. The DAPHNE Advisory Group (DAG) will enable the consortium to engage relevant actors in the aerospace value chain, from component suppliers, through equipment manufacturers to end-users to ensure that a wide section of industry is given the chance to validate the concepts and solutions developed in DAPHNE. The use of photonics for aircraft communications systems is still in its infancy. DAPHNE aims to establish the centre of mass of avionic photonic expertise firmly in Europe.

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Project progress: Baseline studies: existing aircraft networks

Objectives (AgustaWestland Lead)

- Capture requirements for existing and future aircraft data networks:
  - Includes both electrical and optical networks
- Map functionality to aircraft zones and identify data flow characteristics
  - Produce normalised network descriptions to enable quantified analysis
- Identify technology gaps for components and infrastructure
  - Maintenance and repair considerations
  - Consider potential future requirements and integration of legacy with current or future equipment and protocols.

Existing Systems

European aviation covers a wide and diverse transportation role, making the task of looking for common system denominators initially daunting. In order to bound the task, a top-down approach was taken that initially categorises the aircraft types as rotary wing, small fixed wing and large fixed wing. Within these three types, roles and missions were analysed to select a single candidate role for each aircraft type. Further analysis was then carried out on the installed systems and sub-systems and a composite 'generic' system created which possessed the capability to execute the role for each aircraft type.

Image provided courtesy of AgustaWestland; all rights reserved

The system nodes and interconnects were then subjected to a systematic analysis which included physical location, interconnect lengths, connector breaks and environmental tolerance. The information gained in this exercise is a sound understanding of the systems configuration into which the optical components will need to integrate.

Future Systems

The future systems activity identifies 'pressure points' in current avionics architectures, where new requirements are not easily or efficiently met, and also new opportunities in existing systems that, by virtue of changed circumstances, such as component obsolescence or new operating procedures, could be viably undertaken in the optical domain.

Image provided courtesy of Airbus; all rights reserved

The identification of these future applications is key to success in DAPHNE, as it will provoke the development of components by virtue of necessity rather than desirability, which once in existence, can be considered more economically for more established applications. Parallel applications are being sought not just with the telecommunications sector, but also in other modes of transportation such as the automotive and rail sectors.

Project progress: Baseline studies: terrestrial technology

Objectives (G&H Lead)

- Review terrestrial network techniques and architectures
  - Latest WDM (wavelength division multiplexing) technology
  - FTTX (fibre to the X; X= home, kerb, office *etc.*)
- Photonic component maturity assessment
  - Active and passive components
  - Cables and connectors
  - Identify gaps in functionality and performance
  - Define work necessary to develop components for aircraft application.

Terrestrial network architectures

A comprehensive survey of currently deployed and research terrestrial telecommunications networks has been undertaken by the DAPHNE partners. The study ranges from automotive systems which use plastic optical fibre (POF) to send low bit rate data around a car to ultra-high data-rate systems used for long haul telecommunications.

An aircraft will require the best of both worlds: an easy-to-implement system that works in a harsh environment together with fast data-rates and high reliability required by the latest avionic systems and in-flight entertainment (IFE). Fibre-to-the-home (FTTH) systems are being deployed to provide residential users with high speed internet. These systems use a combination of a passive optical networks (PON) and WDM. These FTTH networks have several similar requirements to aircraft:

- A well controlled head end
- A transmission network in a harsh environment
- Many terminals in uncontrolled environments
- Tight power limitations.

This is driving the development of cost-effective and rugged components that can be deployed in the street as well as on board aircraft.

A 1 × 128 passive fibre splitter: a key PON component

Transmission of radio and microwave frequencies over fibre offers considerable advantages over traditional copper cable in terms of weight, cost and electromagnetic interference. The DAPHNE project is surveying the latest RF optical techniques so that these can be applied to the development of an RF over fibre network for aircraft.

A fused fibre coupler: a robust optical filter and splitting technology

Photonic components

A wide range of photonic components has been developed for terrestrial communications, but most have not been designed for operation in aircraft. The DAPHNE project is analysing the latest developments in photonic components and undertaking an assessment of component suitability for a range of demanding aircraft applications.

A small form factor transceiver for aerospace applications

The range of components studied includes: transmitters, receivers, wavelength multiplexers, power splitters, optical switches and a range of optical fibres and connectors. Consortium partners have developed their own ruggedised components for aircraft such as the fused splitters from G&H, planar splitters from SQS (see above) and transceivers from D-Lightsys.