Lessons learnt from fibre optics in aircraft

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Introduction

- Todays Presentation:
  - History
  - Differences seen between space and aero
  - Previous barriers
  - Current State of the Art
  - Learning from Aerospace

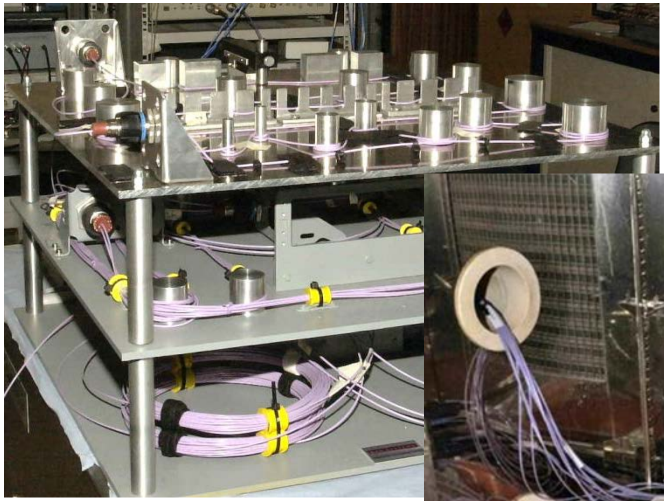
YOUR REQUIREMENTS, OUR CAPABILITY

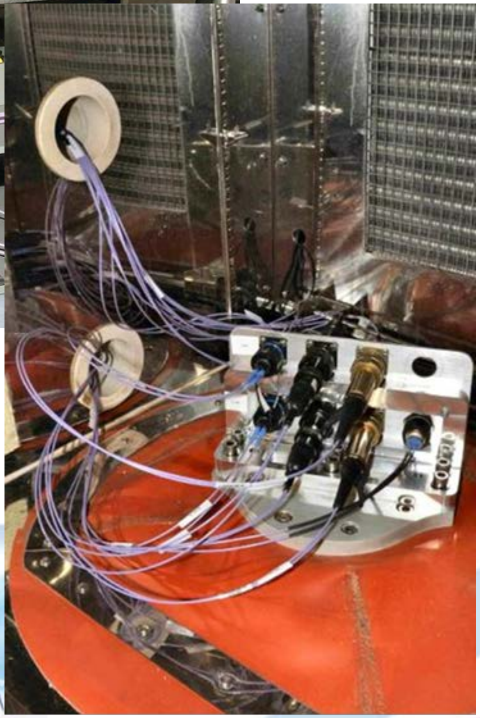
Who are we?

AS9100 certified company formed in 2005

Specialise in research, designing, developing and manufacturing Fibre Optics in Harsh Environments

- **Harsh Environment Fibre Optics**
- **Free Space Optical Communications**
- **Fibre Optic Sensing and Structural Health Monitoring**
- **Hyper-Spectral Imaging**
- **Electronic Design and Prototyping**
- **Tuneable IR Laser Systems**





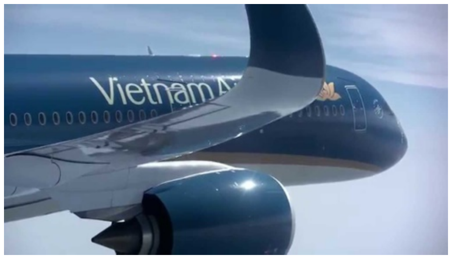
Environmental testing of different multi-way connectors

History of Fibre in Aerospace

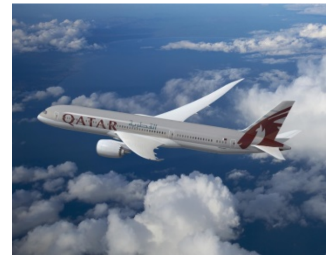
- Fibre optics first flew over 30 years ago
- Adoption and standardisation however has taken a long time
- It is still an ongoing process
- Driver for adoption was security and EMI
- Data has only become more prevalent as adoption of more commercial technologies has become possible and digital video requirement has grown.
- It is still seen by many as a new and 'risky' technology.

AVoptics LightWorks
YOUR REQUIREMENTS, OUR CAPABILITY

Aircraft Using Standardised Fibre Optic Components


A350 - XWB


A380-800



Boeing 787


AIRBUS A340-600


Boeing-Lockheed Martin
F-22 Lightning


BAE SYSTEMS
TYPHOON


AIRBUS A400M


LMCO F-35


AW -101 MERLIN HC.3


BOEING CHINOOK HC.3


AW -159 WILDCAT

What is the Gap between Aviation and Space

- Main requirements differences:
  - Military avionics requirements are similar or harsher than a typical LEO (SP2) system
  - SP3 however considerably colder
  - Radiation and outgassing requirements remain the two main fundamental differences.
  - However, this is changing with a big push towards the next generation of military UAV's
    - High altitudes and harsher radiation requirements
    - A lot of the information regarding radiation requirements of UAV is difficult to show publicly.

Previous barriers to adoption in aerospace

- Perception
- Supportability
- Training and knowledge
- Real requirement
  - Only implemented recently for bandwidth
  - Security and EMI historically
- Cost

- Previously poor technology selection **and** practices selections has, in cases, discouraged adoption

Current State of Aerospace

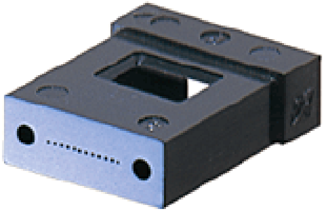
- Still predominantly mission systems and not flight critical
- Majority of systems are 2.5Gbps or less.

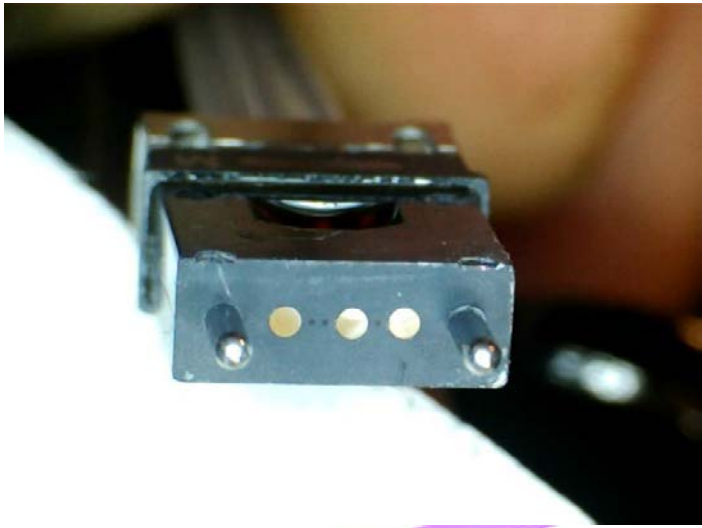
- Applications:
  - Data communications
  - Secure communications
  - Fibre optics sensing
    - Impact detection (growing with composites)
    - Stress, strain and temperature

Databuses

- Avionics Full-DupleX Switched Ethernet (AFDX)
- GBE and Fibre Channel (Mainly in video systems)
- ARINC818 etc…
- Majority of systems are point to point
- Custom Passive Optical Network Systems
- Long term trend is towards 10 GB Ethernet
- Components are mainly:
  - Multimode OM3 / OM4
  - VCSEL Systems (850nm or 1300nm)

Databuses



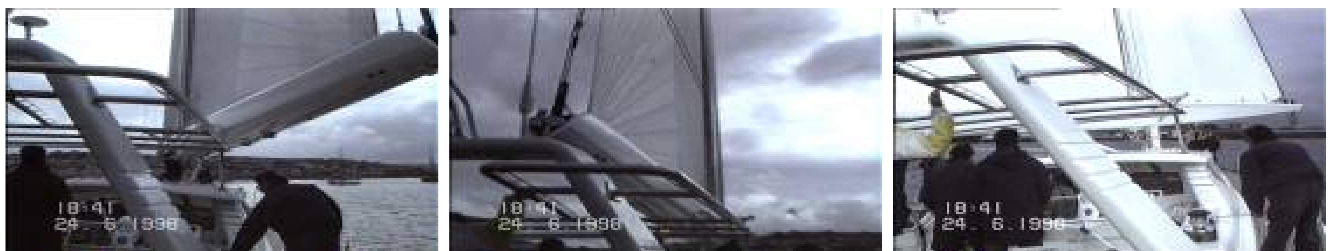


- Research work on:
  - CWDM systems
  - Ring networks
  - PON systems
  - Legacy Conversion
- Adoption & Conclusions
  - Avoid external media converts where possible
  - Multi-Mode and VCSEL's
  - Ribbon fibre rapidly gaining ground
    - Less components to qualify and lower risk compared to other systems.
  - Inside the box free space optics shows promise

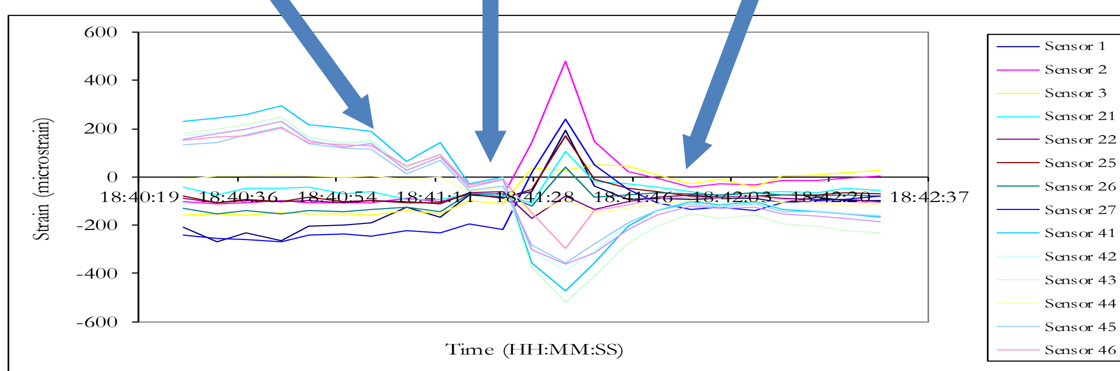
Sensing

With the rise in composites interest in load sensing and monitoring has risen:

- Almost entirely single mode



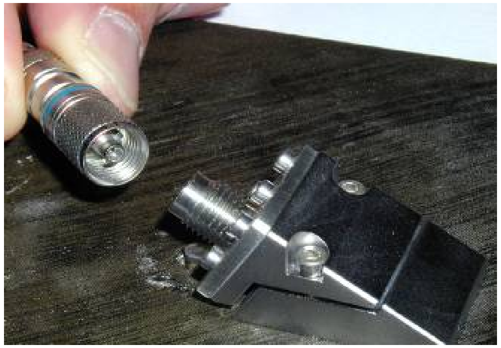
Sea-Trial 1: Tack 1

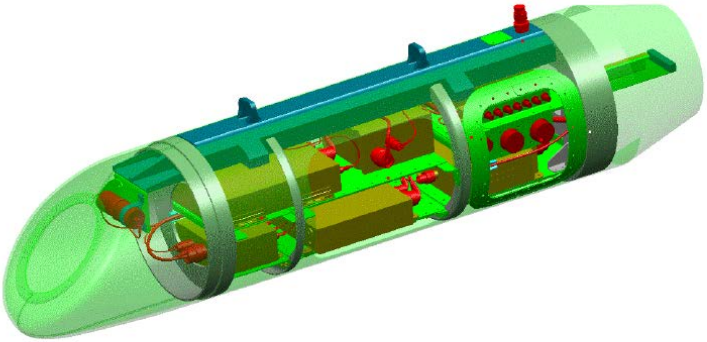


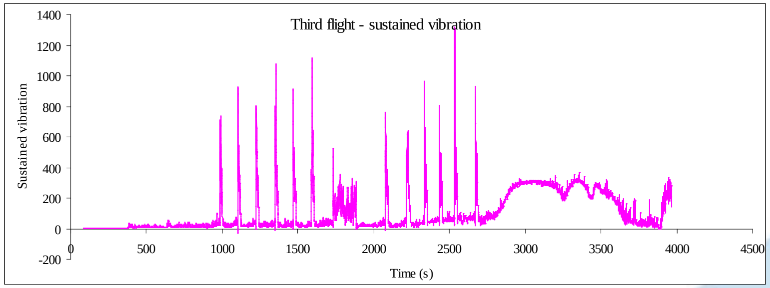
Sensing

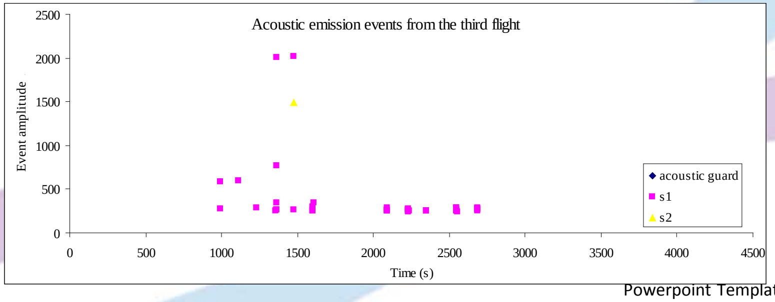
Damage detection

- Acoustic Emissions detection

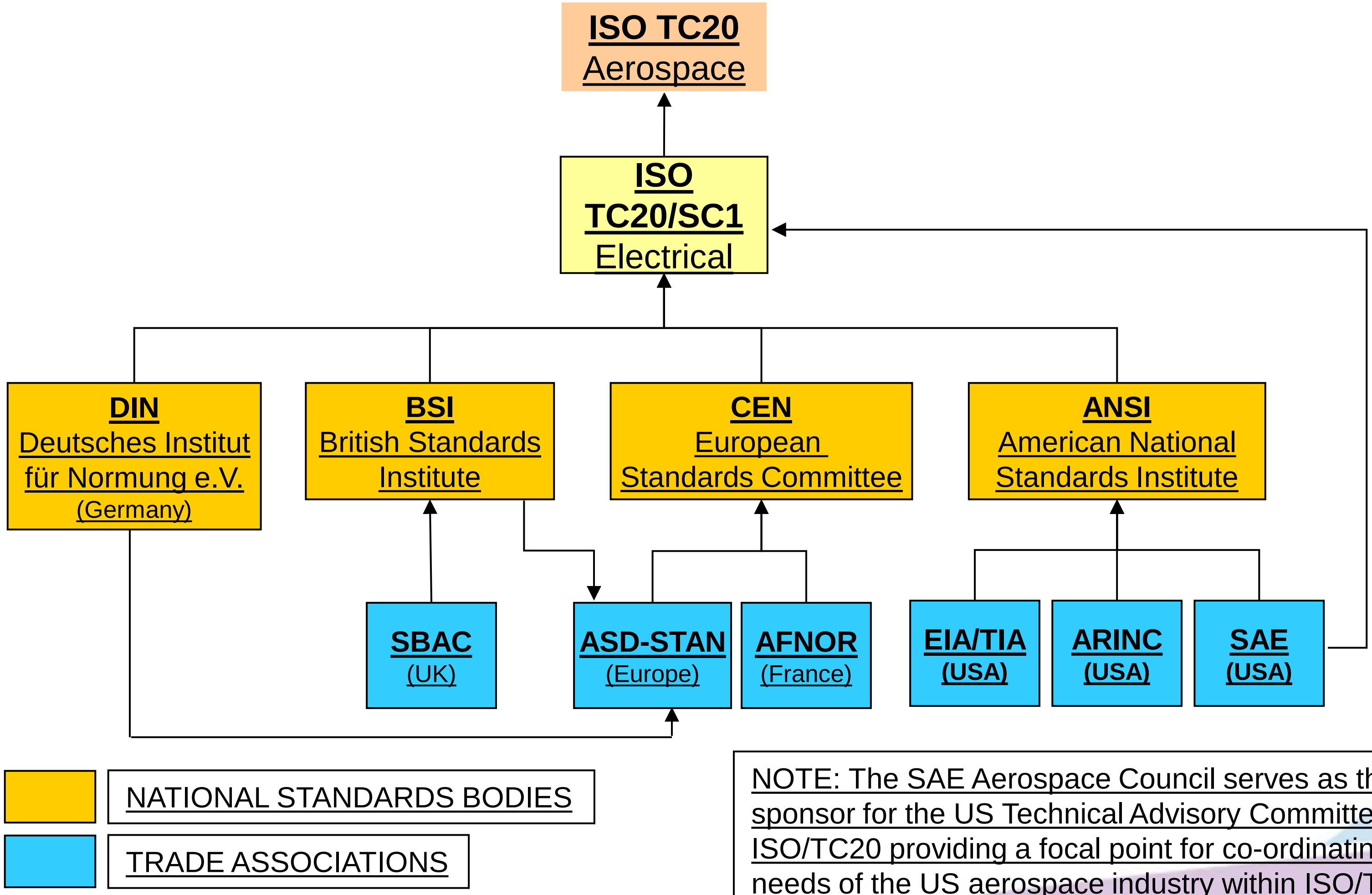








Standards Roadmap



NOTE: The SAE Aerospace Council serves as the US sponsor for the US Technical Advisory Committee for ISO/TC20 providing a focal point for co-ordinating the needs of the US aerospace industry within ISO/TC20.

ARINC Standards

- ARINC801 – Termini / Connectors
- ARINC802 – Cable
- ARINC803 – Design Guidelines
- ARINC804 – Active devices
- ARINC805 – Repair and Maintenance
- ARINC806 - Testing
- ARINC807 - Training

Learning from Aerospace

- Multiple standards means no standard
- DAPHNE & FONDA programmes showed:
  - Optics aren't always cheaper and lighter.
    - Qualification cost, end system costs, power requirements for MIA's.
  - Multimode can do most things, sensing or RF is the driver for single mode.
- Training and understanding of the technology is key, from designer to manufacturer.
- Easy supportability makes adoption easier

Learning from Aerospace

- UAV requirements will be driving some aerospace components in the space direction
- Try to move optics into end systems
- Route optics and electrical harnesses together
- Interest in ribbon fibre is growing rapidly
- Smart structures are coming
  - How to interface to structure is a challenge
- Fibre is highly reliable
- Telecoms can mean high obsolesce risk as well
- RF optics and sensing will drive single mode

Thank you

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