FIA Summer Seminar 2019

The Use of Fibre Optic Technology in Aerospace

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Early Commercial Applications of Fibre Optic Technology in Aerospace

1993 - G-ASYD BAC 1-11 Control Technology Project (CTP) Development of Smart Actuation Systems 'Fly-by-Light'

Lucas Fly-By-Light spoiler actuation system. System provided lift dump, airbrake and roll assist smart actuation system control to the aircraft. 'First fare paying passenger service'.

1995 – Boeing 777 Optical Local Area Network (OLAN)

FDDI based networks over 100/140 µm fibre. Avionics Local Area Network (AvLAN) and Cabin Local Area Network (CabLAN). CabLAN discontinued. AvLAN provided Maintenance, Pilot and Portable Maintenance Access Terminals. System became obsolete due to non-availability of FDDI chipsets.

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Commercial Aerospace Fibre Optics In-Service Timeline

2002 – Airbus A340-600 enters service with Taxi Aid Camera system utilising point-to-point fibre optic links between cameras mounted on the forward fin and belly fairing

2007 – Airbus A380 enters service with first aircraft manufacturer installed fibre optic backbone for In-Flight Entertainment (IFE) system, plus fibre optic Enhanced Taxi Aid Camera System (ETACS)

2011 - Boeing 787 enters service with extensive use of fibre optics on a number of systems including Common Data Network utilising ARINC 664 with bi-directional signalling and IFE backbone

2015 – Airbus A350XWB Systems developed on the A380 have been updated for use on systems including IFE, Avionics Head up Display (HUD).

Challenges Encountered implementing Fibre Optic Technology in Aerospace

- **Harsh environment**
  - Temperature (-65 ° C to +150 ° C)
  - Vibration (Engine blade out)
  - Shock (High ‘g’ effects)
  - Contamination (SWAMP, fuel, oils, etc.)

- **Perceptions**
  - Lack of knowledge of fibre optic technology
  - ‘Optical Fibres can easily be broken’
  - ‘Fibre optics not as rugged as electrical cables’
  - ‘What are the advantages of using fibre optics?.

Market Drivers for Fibre Optics in Aerospace

- Immunity to EMI

  Fibre neither emits or is susceptible to EMI

- Integrity of transmitted data

  Immunity to external interference

- Scalability

  Cable installations last from manufacture through installation onto decommission of aircraft

  Built in upgrade capability

- Weight savings

  Magnitude of 100’s kg savings on large aircraft e.g. Quadrax cable 45 g/m, Fibre optic cable 4.5 g/m Max

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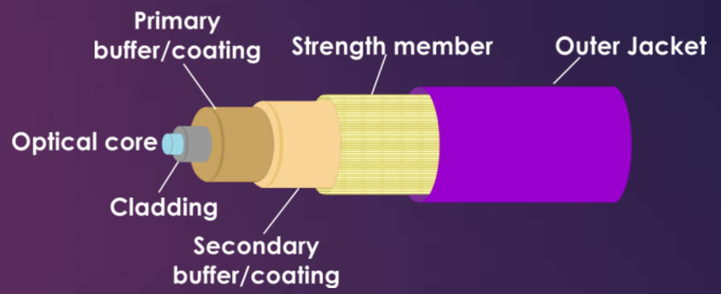
Aerospace Research & Development Projects Achievements

1997-1999, FOHS II (Fibre Optic Harness Study II)

2000-2003, LOADNet (Low Cost Avionics Data Network)

FOHS II → LOADNet

- → 60/125 µm Tight structure Fibre Optic Cable
- → Aerospace Fibre Optic Connector & 2.5 mm Terminus



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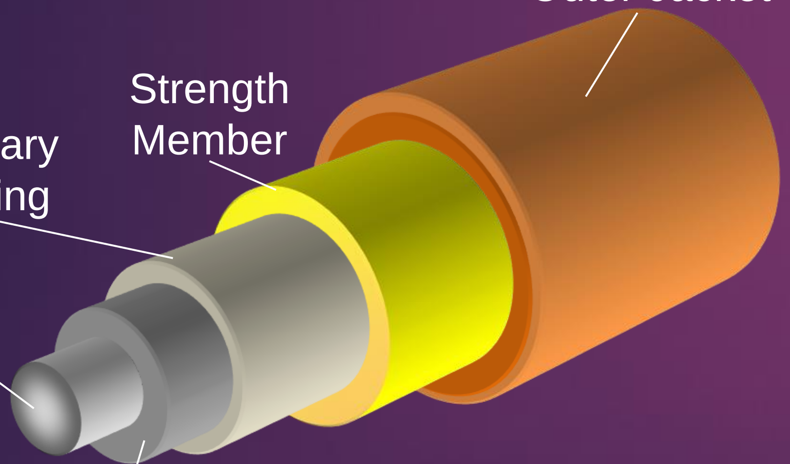
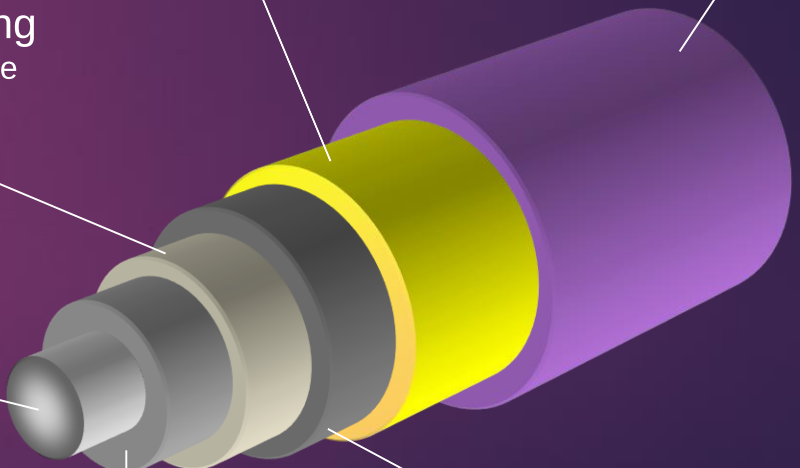
Datacom Versus Aerospace Passive Components

Fibre Optic Cables

Datacom Cable



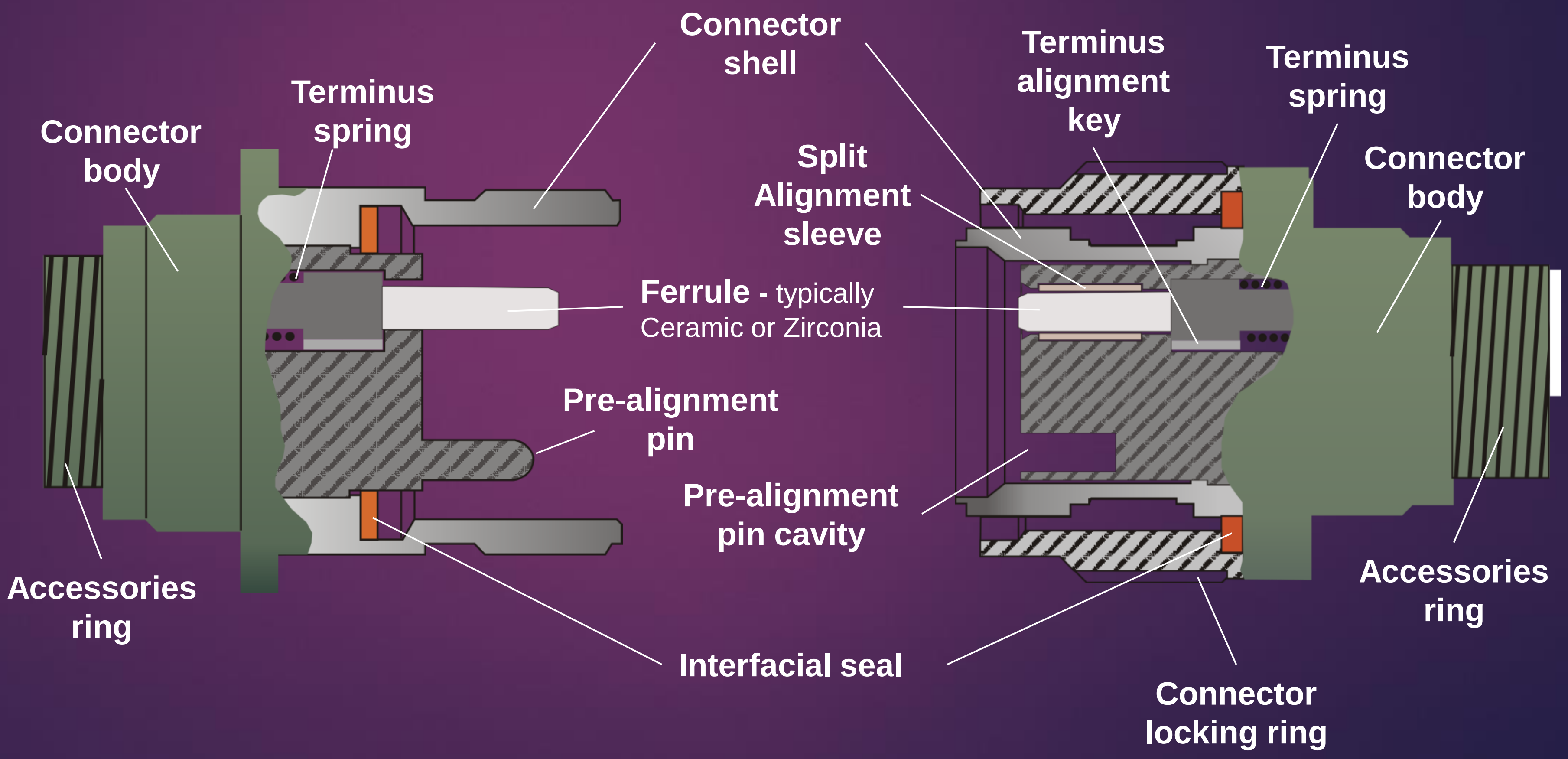
Aerospace Cable



Datacom Versus Aerospace Passive Components

Fibre Optic Connectors

MIL-DTL-38999 Series III type connector



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Examples of Qualified Aerospace Connectors & Associated Fibre Optic Termini

MIL-DTL-38999

Elio EN 4531

Elio EN 4531-101

Ruggedised Singleway Connector (RSC) EN 3733

MC-5

MIL-PRF-29504

LuxCis EN 4645-003

LuxCis EN 4639-002

LuxCis EN 4639-101

NOTE: New designs of multi-fibre (MT) modular & circular connectors are currently being qualified for commercial aerospace applications

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Considerations for Fibre Optics in Aerospace

- Short overall lengths/frequent connections require differences in:
  - Testing
  - Supportability
  - System Power Budgets
- Environment
  - Robust components to work in high temperature, vibration, heavy contamination areas
  - Routing requirements in small space envelopes
  - New packaging to exist in harsh environments

Elements Affecting Performance

- Poor installation or assembly techniques (e.g. tight bands, trapped cable)
- In Service, maintenance induced damage (accidents, poor maintenance techniques), not following maintenance procedures
- End face contamination (exposed connectors, poor handling)
- Termination / assembly defects.
- Poor ‘husbandry’ e.g.
  - Lack of cleaning prior to mating connectors
  - Not following cleaning procedures
  - Not completing Inspection, cleaning, inspection prior to initial connection of new optical links

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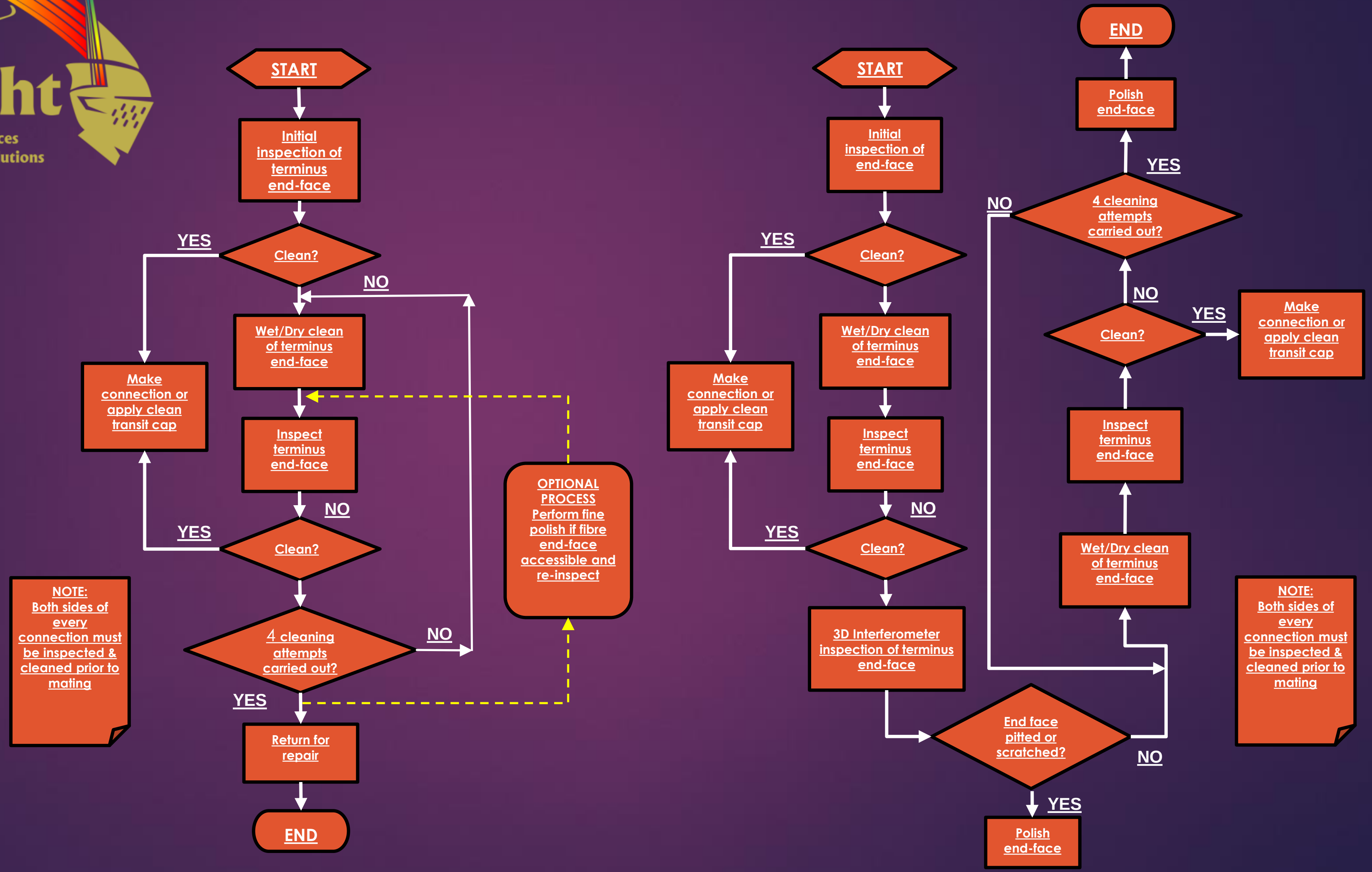
Inspection & Cleaning

- Cleaning is critical to maintaining optimum performance of any aerospace fibre optic application.
- > 85 % of current system failures can be attributed to poor inspection & cleaning!
- Common consensus in aerospace community:
  - Inspect, Clean (if necessary), Inspect philosophy
  - Use of video inspection microscopes & Pass/fail software (where applicable)
  - Use of wet/dry cleaning processes *(NO IPA!)*

Inspection & Cleaning Flowcharts



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Training

Training is an essential element of ensuring aerospace fibre optic reliability

Two documents developed for development of aerospace fibre optic training syllabus:

- SAE ARP5602 Guideline for Aerospace Platform Fiber Optic Training and Awareness Education, Introduction to Aerospace Fiber Optics (14 elements)

- ARINC 807 Fibre Optic Training Requirements

Training programmes Electronics Technicians Association (ETA) accredited

Aerospace Standards

Aerospace standards committees have worked to produce standards that define test methods and qualification of aerospace fibre optic components. These standards include:

ASD STAN

- EN 2591, Elements of electrical and optical connection- Test methods – General
- EN 3745, Fibres and cables, optical aircraft use - Test methods

ARINC

- ARINC 801 Fibre Optic Connectors
- ARINC 802 Fibre Optic Cables

In many cases test methods have been developed from telecommunications standards such as EIA-455

Future Aerospace Fibre Optic Applications

Research & development of aerospace fibre optics is targeting a number of areas including:

- Fibre optic sensors:
  - Structural health monitoring
  - Aircraft heavy landing indication
  - Fuel level & contamination sensing
  - Predictive maintenance
  - Wheel speed
  - Real time weight monitoring
- Power by light:
- Wavelength Division Multiplexing over Multimode fibre
- RF over fibre

SAE Aerospace Information Report - AIR6258 Fiber Optic Sensors for Aerospace Applications

SAE Aerospace Recommended Practices – ARP6366 Fiber Optic Sensor Specification Guidelines for Aerospace Applications

SAE Aerospace Information Report - AIR5601 A Guideline for Application of RF Photonics to Aerospace Platforms

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Conclusions

- Aerospace fibre optics is now a mature technology
- Aerospace fibre optic installations are extremely reliable
- Training is proving effective but needs to expand
- Aerospace fibre optics applications continuing to expand

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Examples of In-service Commercial Platforms Incorporating Standardised Fibre Optics Components

Airbus A350-900

Boeing 787-9

Airbus A330-900 neo

Gulfstream G650

Airbus A380

Airbus A340-600

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Thank you

Any Questions?

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