Standards for Space Flight Optical Fiber Components

Melanie N Ott
NASA Goddard Space Flight Center
Parts, Packaging and Assembly Technologies Branch

Outline

- Introduction
- Issues of Qualification
- Industry Solution
- Military Solution
- Status to Date
- Conclusion

Introduction

- There are no military standards for space flight optical fiber components
  - Fiber optic components have been in space flight use for over 30 years.
- Although some aerospace standards exist through the SAE Aerospace (Society of Automotive Engineers), there are no qualified parts to these standards.
  - No qualifying authority activity.
- This means all optical fiber components have the "Commercial Off The Shelf" COTS burden to the customer.
  - Qualification testing requires lot buys and are costly in time and money.
- No standards can also mean, no bid from vendors.
  - No precedent for space flight requirements,
  - Vendors find that the low volume with the list of requirements doesn't fit their business plan,
  - Which limits our technology development ability.

To be presented by Melanie N. Ott at the NASA Electronic Parts and Packaging (NEPP) Program Electronic Technology Workshop, Greenbelt, Maryland, June 28-30, 2011, and published on nepp.nasa.gov.

Define "Qualification"

Are you rich or are you poor?

- $$$$= MIL-STD's + Telecordia + NASA Requirements
  - Lifetime Lot buys for COTS parts or anything that will go obsolete.
- $$$ = Telecordia + NASA Requirements
  - Buy critical parts , qualify by Lot.
- $$ = COTS Approach for Space Flight (NASA Requirements)
  - Requires careful planning especially with materials selection
  - Lot specific testing
  - Destructive physical analysis necessary early on
  - Radiation testing performed early in selection phase.

To be presented by Melanie N. Ott at the NASA Electronic Parts and Packaging (NEPP) Program Electronic Technology Workshop, Greenbelt, Maryland, June 28-30, 2011, and published on nepp.nasa.gov.

Industry Solution; JEDEC 13.6 Fiber Optic Standards For Space

- **The Joint Electronic Devices Engineering Council or JEDEC JC-13**
  - **responsible for standardizing quality and reliability methodologies for solid state products used in military, space and other special environments.**
- **JC-13, Formed a group to draft space flight standards for fiber optic components.**
  - **Driven by the immediate need for transceiver standards and the supporting subcomponents for vendors.**
  - **In coordination with the (Society of Automotive Engineering) SAE AS-3, Fiber Optics and Applied Photonics Standards for Aerospace.**

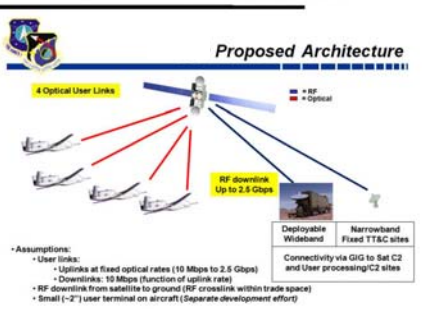
SAE International

Where are the Space Users Needs Coming From?

JEDEC

"Sensor To Shooter" - Increased Sensor To Processor Raw Data Rates

Array Size (Megapixels)	Frame Rate (Hz)	ADC Resolution (bits)	Raw Data Rate (GBPS)
0.5	2	12	0.015
0.5	20	12	0.15
0.5	200	12	1.5
0.5	2000	12	15
0.5	20	12	0.15
0.5	20	16	0.2
0.5	20	24	0.3
1	2	12	0.03
1	20	12	0.3
1	200	12	3
1	2000	12	30
1	2000	16	40
2	2	12	0.06
2	20	12	0.6
2	200	12	6
2	2000	12	60
2	20	16	0.8
2	20	24	1.2
2	200	16	8
4	2	12	0.12
4	20	12	1.2
4	200	12	12
4	2000	12	120



- 4 megapixel camera at 2Khz frame rate with 12bit ADC sampling generates 120Gbps raw data
  - Drives On-Orbit Memory Storage Capacity
  - Driving On-Orbit Processing Power required
    - Significant Parallel Processing (Cores and DSPs)
    - Separate SERDES function

3

Objective of JEDEC 13.6

The JC-13.6 Subcommittee's objective is to publish and maintain a comprehensive test and qualification standard for fiber optics in harsh-environment applications, with emphasis on commercial and military avionics in missile and space systems.

No.	Component Type	Chair POC	Email / Phone
13.6.001	Transceivers (Transmitters, Receivers)	Mike Borbath, Harris Corp.	mborbath@harris.com 321.727.6010
13.6.002	Actives (Pump Lasers, Diodes)	John Mazurowski Penn State Optical Center	jmazurowski@eoc.psu.edu 724.295.7000
13.6.003	Passives (Isolators, circulators, couplers)	David Meshel, Aerospace Corp.	David.c.meshel@aero.org 703.808.5469
13.6.004 W/ SAE	Connectors/ Cable	Melanie Ott, NASA	Melanie.ott@nasa.gov 301.286.0127
13.6.005	Switches	Keith Avery	Keith.avery@kirtland.af.mil 505.846.0210
13.6.006	Fiber Sensors	John Mazurowski Penn State Optical Center	jmazurowski@eoc.psu.edu 724.295.7000
13.6.007	Reliability / Maintainability	Nikki Parson	Karletta.n.parson@lmco.com 817.935.5590

Status of JEDEC 13.6

- **Transceiver subcommittee has a matrix of test requirements**
  - **Qualification, acceptance quantities agreements.**
- **Cable & Connectors subcommittee matrix is 80% complete**
  - **most of which occurs at SAE standards meetings.**
- **Fiscal year 2012 for draft documents from test matrix, some groups still formulating matrix.**
- **Group has taken some time out to assist with new MIL-STD which is expected to be completed Fiscal year 2012.**

New Military Standard in Draft

MIL-STD-XXXXX
Draft 1
7th of Apr. 2011
Photonics Standard Proposal

MILITARY STANDARD

PHOTONIC (OPTICAL and ELECTRO-OPTICAL) DEVICES,
GENERAL SPECIFICATION FOR

This standard is approved for use by all Departments and Agencies of the Department of Defense.

This document is a military standard. It is intended to provide the device manufacturers an acceptable established baseline in order to support government photonic and electro-optical device applications and logistic programs. The basic document has been structured as a military standard that is supplemented with detailed appendices. These appendices provide methodology to manufacturers for meeting this military standard's requirements. These appendices are included as a requirements benchmark and are intended to impose minimum mandatory requirements. For QML devices the manufacturer is required to develop a program plan that enables the finished products to meet or exceed the requirements detailed in these appendices (see appendices).

1. SCOPE

1.1 Scope. This standard establishes the minimum requirements for both active and passive photonic and electro-optical devices, and includes, but is not limited to, laser diode modules, optical transceivers, optical modulators, optical filters, optical amplifiers, optical receivers, etc. In addition, this standard provides the verification requirements for ensuring that these devices meet the applicable requirements. Verification is accomplished through the use of one of two quality programs (Appendix A). The main body of this standard describes the device requirements and the requirements for obtaining a Qualified Manufacturers List (QML) listing. The appendices of this standard are included as a benchmark and are intended to impose minimum requirements. Detailed requirements, specific characteristics, and other provisions that are sensitive to the particular intended use shall be specified in the applicable device acquisition specification.

Need for Harmonization

- **Multiple institutions have created standards for fiber optics, some for military environments (connectors/cable)**
  - **Electronic Industries Association / Telecommunications Industries Association (EIA/TIA)**
  - **SAE (Aerospace Standards)**
  - **Telecordia (Bellcore Standards)**
  - **International Electrotechnical Commission (IEC)**
  - **European Norms (EN)**
  - **Aeronautical Radio Incorporated (ARINC)**
  - **Military Standards (MIL-STDs)**
- **As a result of JEDEC/SAE activities, a day at the Navair Joint Fiber Optic Working Group was held to discuss available standards from the list above.**

Conclusions

- **JEDEC drafting requirements standards for space environments.**
  - **SAE handling majority of connectors/cable draft**
  - **Establishing harmonization to chose the standards that match the technologies.**
- **MIL-STD being drafted now**
  - **Issue of qualifying responsibility needs to be addressed.**
- **Do you have any specific needs to be addressed by these committees?**