Optical Wireless for intra-Spacecraft Communications
INTA / ESA-ESTEC Contract 19545 / 06 / NL / GLC

CCSDS Fall Meeting – Wireless Working Group
Berlin October 14th, 2008

© INTA (OWL-PRE-7000-04-INTA)
FRAMEWORK

INTA / ESA-ESTEC TRP Contract

Phase I – 9 months (0.5 M€) – Finished December 2006
Phase II – 15 months (1 M€) – Finishing December, 2008
OUTLINE

1 – Optical Wireless for intra-Spacecraft Com’s?

2 – “Harnessing” a Roadmap for OWLS

3 – “Powered” by COTS Optoelectronics

4 – “Networking” with OWLS

5 – “Facing” to the Future

6 – Conclusions for CCSDS Wireless Working Group
1 – Optical Wireless for intra-Spacecraft Com’s?
Evolution in Space to Optical Data Links

INTA Vision by 2000

Electrical

Optical

Low weight
Low cost
Modularity

Standardization and Flexibility

Less harnessing
Reduces interfaces in integration and test phase

Light weight
No EM/EMC problems
Eliminates ground loops

Point-to-point

Low complexity connections
OBDH overload (as subs. grow)
Excessive harnessing

Subsystems

Data Links

Bandwidth

Bandwidth

1773

Optical fibers

Wired

~1990

Missions

MAP
MTP
TRMM
XTE
HST
SAMPEX

~1980

Electrical wires

Point-to-point

~1980

~1980

~2000

>2000?
2 – “Harnessing” a Roadmap for OWLS
OWLS: A Roadmap
1999 – 2008 and...

50 k€ Activity
Basic blocks for the LEGO Demonstrator

Detectors

LED

Emitter/detector

Microcontroller

Autonomous Power
**OWLS: A Roadmap**

1999 – 2008 and...

(200+200) k€ GSP Activity
INTA / ESA GSP Contract

OWLS Demonstrator
Delivered to ESA (2004)

OWLS CAPABILITIES

• FDMA + WDMA incorporated
• 1553-MIL-STD Wireless Bus
• 120 optical transmissions
  (80 Analog & 40 Digital)
OWLS Implementation of a network of RTU’s with MIL-STD-1553
OWLS Modules for MIL-STD-1553

Emitters

Detector
OWLS μRTU’s with sensors
(some examples)
OWLS: A Roadmap
1999 – 2008 and...

Flight experience
NANOSAT 01

In Orbit since Dec. 18th 2004
**OWLS Experiments**

*Optical Wireless Links for intra-Satellite communications*

TM/TC of an ACS magnetic sensor & BER link degradation by radiation)
OWLS: A Roadmap
1999 – 2008 and...

- LEGO Demonstrator
  December 2000

- ESA Demostrator
  June 2004

- NANOSAT 01
  Dec. 2004

- FOTON M3
  October 2007
FOTON M3: *Harnessing light*  
October 2007
OWLS: A Roadmap
1999 – 2008 and...

- LEGO Demonstrator
  December 2000
- ESA Demonstrator
  June 2004
- NANOSAT 01
  Dec. 2004
- FOTON M3
  October 2007
- Venus Express mock-up
  July 2008
OWLS: A Roadmap
1999 – 2008 and...

- LEGO Demonstrator
  December 2000

- ESA Demonstrator
  June 2004

- NANOSAT 01
  Dec. 2004

- FOTON M3
  October 2007

- OPTOS
  2009

- Venus Express mock-up
  July 2008
OPTOS (2009)  A completely optical satellite
3 – “Powered” by COTS Optoelectronics
3 – Starting from *Basics Optoelectronics: Emitters*

OSRAM & VISHAY

Normalized Optical Power vs. Fluence (p/cm^2)

- **High Tolerance**: SFH 4209, SFH 4200
- **Medium Tolerance**: SFH 4600, SFH 4650
- **Low Tolerance**: TSMG2700, TSHG8200, SHF 464
Photodiodes Under Test at INTA

Normalized Responsivity vs. Fluence (p/cm²)

- S5106 (OFF)
- PC20-7
- PC50-7
- C30822
- FFD-200
- C30809
- TMD5010
- TMD5110
- PC10-07

Fluence (p/cm²)

0 5E+11 1E+12 1.5E+12 2E+12 2.5E+12

Normalized Responsivity

0 10 20 30 40 50 60 70 80 90 100
4 – “Networking” with OWLS
Overview of the new Demonstrator: Block Diagram
2.- Communications architecture Overview

- Addressable vs Non-addressable
- Different Non-addressable options

Distributed control demo
OWLS Demonstrator Mock-up: Venus Express
VEX Mock-up for the demonstration
5 – “Facing” to the Future
1 - New CONCEPT – IR Antennas 2009 - 2010
2 - New TECHNOLOGY Breakthrough

Mixed Analog and Mixed Signal Integrated Circuit for OWLS Detectors

OWLS ASIC

~ mid-2010
6 – Conclusions for the CCSDS Wireless Working Group