SPACE MICRO

Design and fabrication of an Optical Appliqué Sensor Interface Module (O-ASIM)

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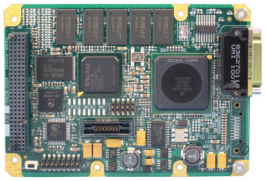
New Facility and Capabilities

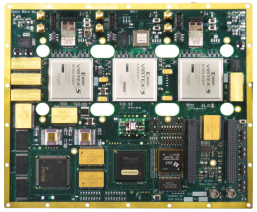
- 20,000 sq. ft
- Improved Clean Room
  - Class 10,000
- Additional Environmental Equipment
  - Thermal vacuum
  - Random vibration
  - Sine vibration
  - Shock
  - Thermal cycling
- SECRET facility
  - COMSEC handling

Radiation Hardened Products

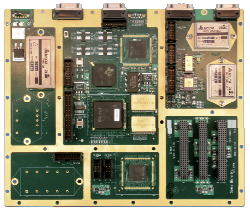
Digital Boards



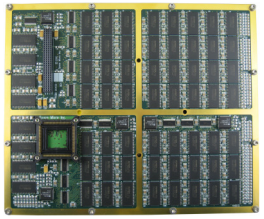
Proton400k-L™Dual-Core Computer



Proton300k™ Reconfigurable SBC

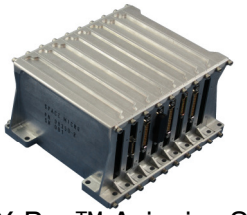


Proton200k™ Custom DSP SBC



Solid State Buffer

Systems/Instruments



ProtonX-Box™ Avionics Suite

------Examples of Configured Slices --------

Proton200k™

FPGA/SpaceWire

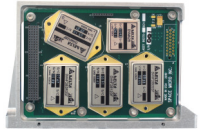
Digital I/O

Analog I/O

GPS (Receiver not shown)

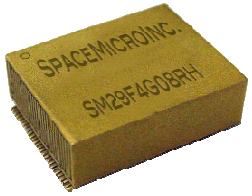
Valve/Relay Driver

Power Switch

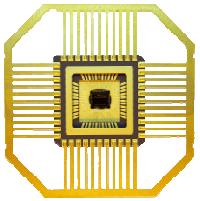


Power Supply

Components

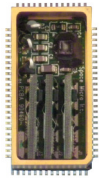


8 Gb RH NAND Flash



H-Core™ Pat. "Watchdog" IC

2.5 Gbps ECC IC

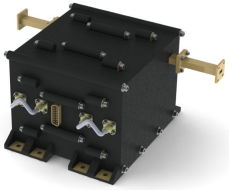


Divert Attitude Controller (DACS)

RF Microwave

uSTDN ™ Transponder

uSGLS™ Transponder



Ka-Band Transmitter

uXLPA™ Linearized SSPA

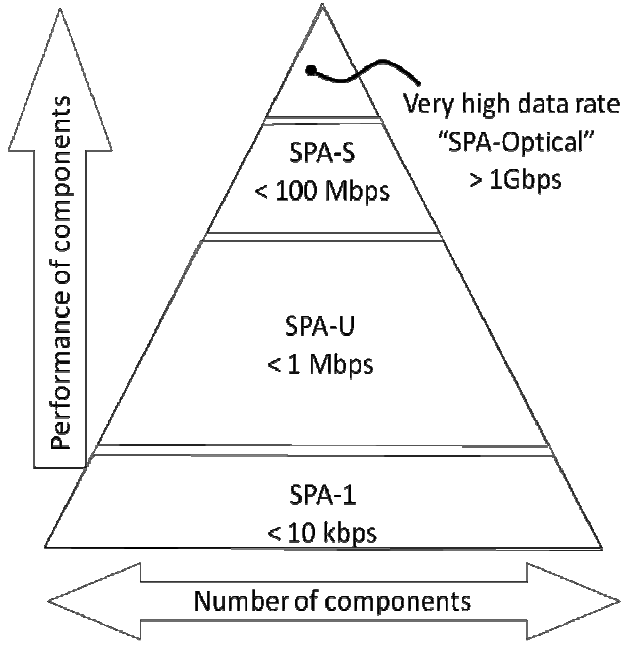
Abstract & Motivation

A key component of the Space Plug-n-Play (PnP) Avionics architecture developed by AFRL/RV for rapid creation and integration of space systems is the ASIM (Appliqué Sensor Interface Module) bridge connecting any sensor/sub-module (e.g. camera, Solid State memory Buffer, CDL, GNC, radar, etc…) to the standardized PnP network. The ever increasing sensor bandwidth requirements –typically driven by imaging and radar systems- are propelling avionics (and as a results ASIMs) into optical domain (O-ASIM). The radiation-hardened O-ASIM, jointly developed by AFRL/RV and Space Micro Inc., will include VCSEL-based short-reach full duplex optical interfaces (4x 10Gbps) with seamless migration to coarse-WDM or 40Gbps for higher throughput. The O-ASIM will offer various client interfaces supporting high-bandwidth sensors as well as an aggregation of multiple lower-speed legacy sensors. The bridge will be radiation-hardened by design. The market-ready product will be manufactured in a convenient single component form-factor with compact optical ribbon fiber connection. The goal of the O-ASIM development is to integrate -in addition to the optical and client interfaces mentioned above- the protocol stack, control plane, fault-recovery and diagnostic logic necessary to convert any spacecraft sub-module to a self-descriptive node of the SPA optical network (SPA-O).

Space Plug-and-Play Avionics (SPA) Model

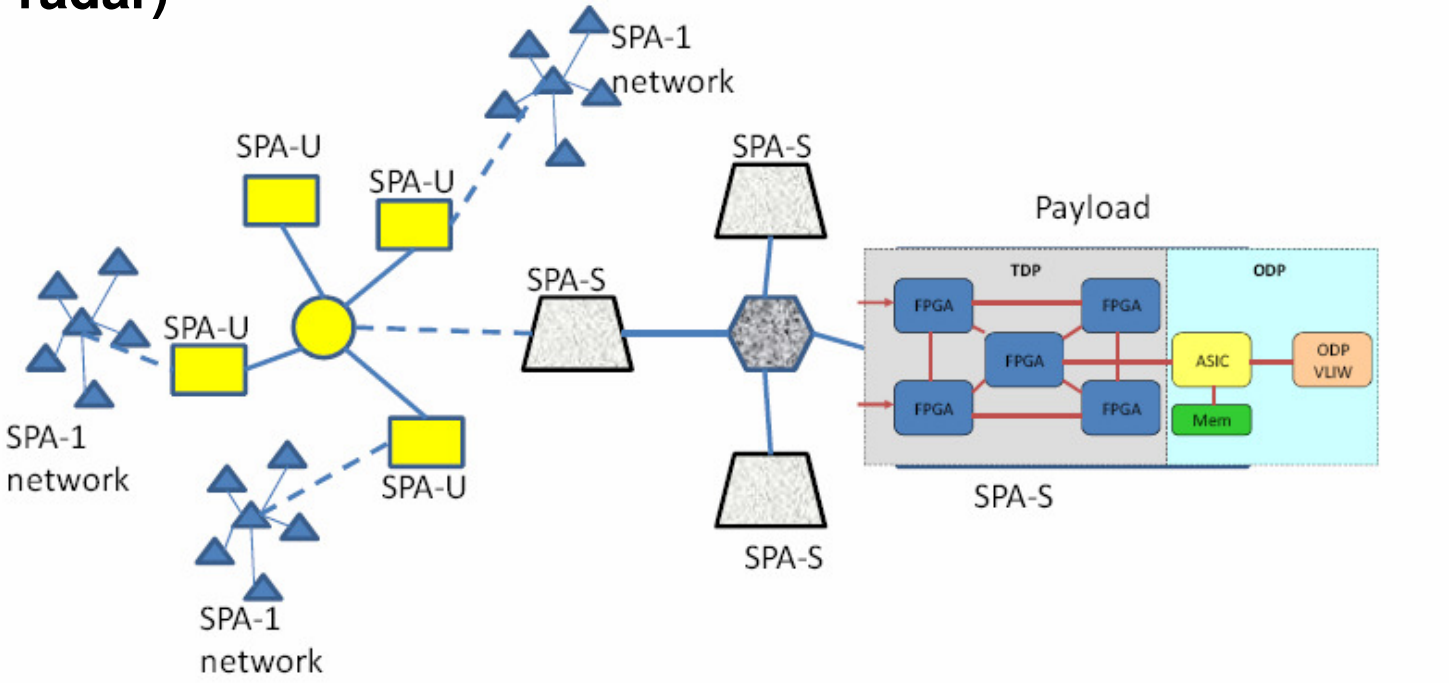
- SPA Developed by Air Force Research Laboratory
- Enables shorter design cycle and AI&T times
- SPA defines a standardized satellite data model (SDM)
- There is a need for multiple data throughput interfaces

- **SPA-O Optical** for high speed > 1Gbps
- SPA-S based on SpaceWire
- SPA-U based on USB
- SPA-1 Based on I2C



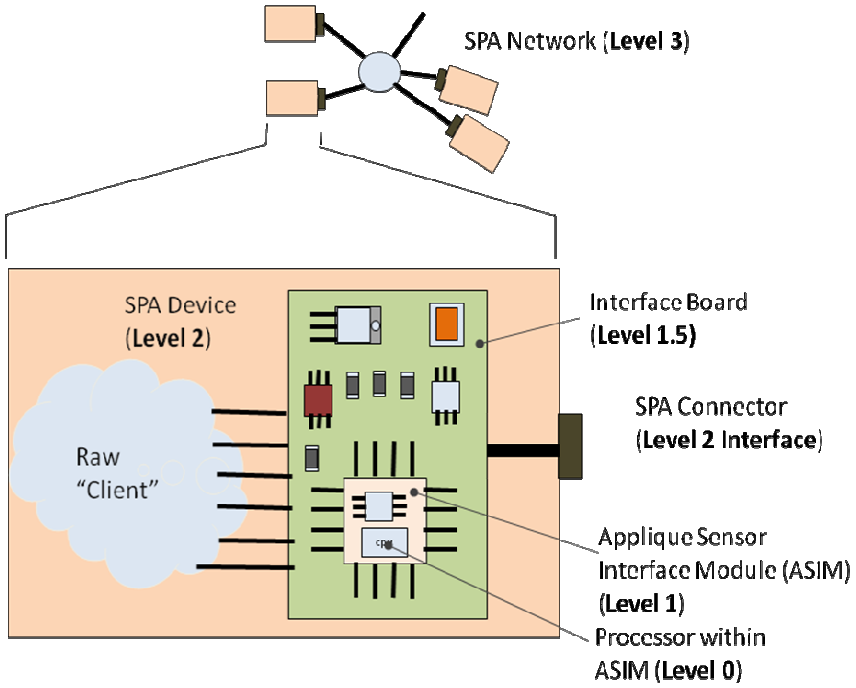
SPA for High-Performance Systems

- **Mixture of SPA networks will make up a composable system**
- **The dashed lines - - - - represent links to gateways**
- **Each SPA device can be a simple device or an entire complex payload**
- **SPA-O is necessary for very high speed payloads (imaging and radar)**



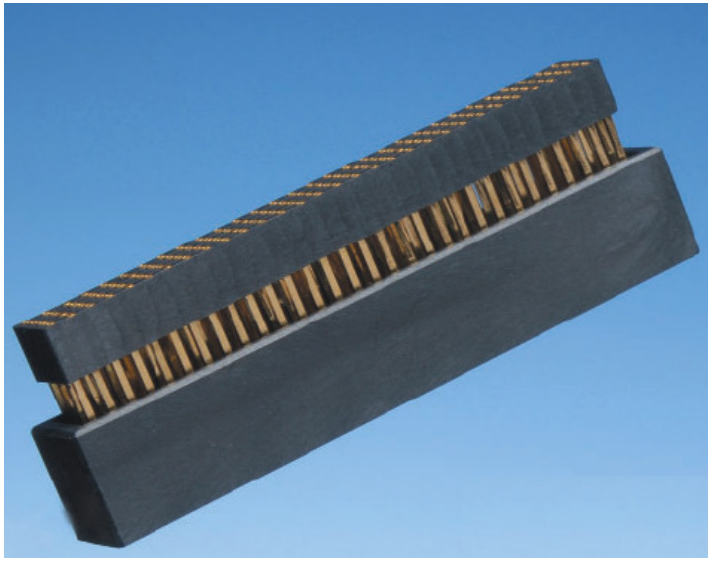
Hierarchy of SPA-based Components

- **ASIMs are used to connect legacy sensor devices to the SPA network**
- **ASIM functions are defined for Level 0 thru Level 3**



General Purpose IO Connector (PCI-104)

- The General Purpose IO Connector is the main component of the client interface
- Initial board will contain a PCI 32bit/33MHz bus
- 132 MBps or 1056 Mbps throughput
- Also support 32 bit/66 MHz
- 264 MBps or 2112 Mbps throughput



- Available in commercial or flight versions
- Space Micro experience on Proton Xbox avionics box

RocketIO CX4 Connector

- CX4 is provided to support a high speed serial IO connection
- CX4 is typically used for Infinband QDR (8 Gbps) and 10 Gb Ethernet
- CX4 supports 2.5 Gbps or 3.125 Gbps per channel
- Contains four transmit and four receive lanes
- Xilinx GTX transceiver supports 6.5 Gbps

O-ASIM Power Requirements

- The O-ASIM board requires 5V and 3.3V inputs
- It contains regulators that supply 2.5V, 1.2V and 1.0V

Power

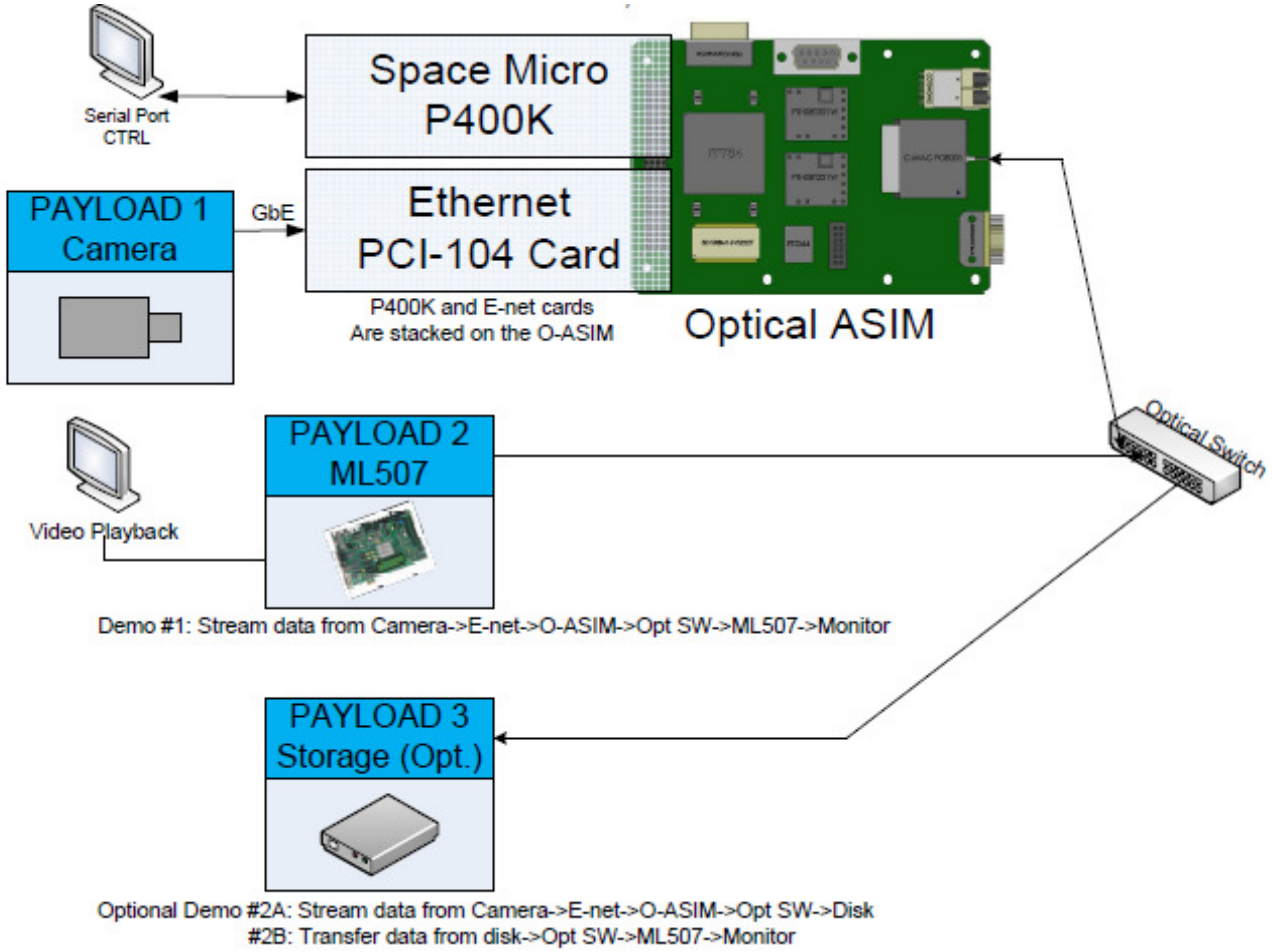
Item	Quantity		3.3V		2.5V		1.2V		1.0V	
Xilinx Virtex-5 Section			Typ(mA)	Max(mA)	Typ(mA)	Max(mA)	Typ(mA)	Max(mA)	Typ(mA)	Max(mA)
1	1	Xilinx Virtex-5 FPGA								
		V_{CCINT}								3425
		V_{CCAUX}				182				
		$V_{CCO3.3}$								
		$V_{CCO2.5}$				33				
		$V_{CCO1.8}$								
		$V_{CCO1.5}$								
		$V_{CCO1.2}$								
		$MGTAV_{CC}$								201
		$MGTAV_{CCPLL}$								0.114
		$MGTAV_{TTTX}$						113		
		$MGTAV_{TTRX}$						101		
2	1	FlashROM, 128Mx1 +Socket			23	28				
3	1	SRAM, 72Mb, 2Mx36, 4WordB, 200MHz		260						
4	1	UART Buffer				1				
5	1	Quad Optics Module	425	***500***						
6	1	Single Optics Module	175	240						
7	1	Oscillator, CORE_REFCLK, 100MHz		60						
8	1	Oscillator, LVDS, 200MHz		80						
9	8	LEDs/pushbuttons				80				
		MISC		100		100				
		Current (mA)		**1240**		**424**		**214**		**3626**
		Power(W)		**4.092**		**1.06**		**0.2568**		**3.626**

TOTAL O-ASIM POWER 9.03491 Watts

NOTES:

1. Bold Italic are estimates

O-ASIM System Diagram

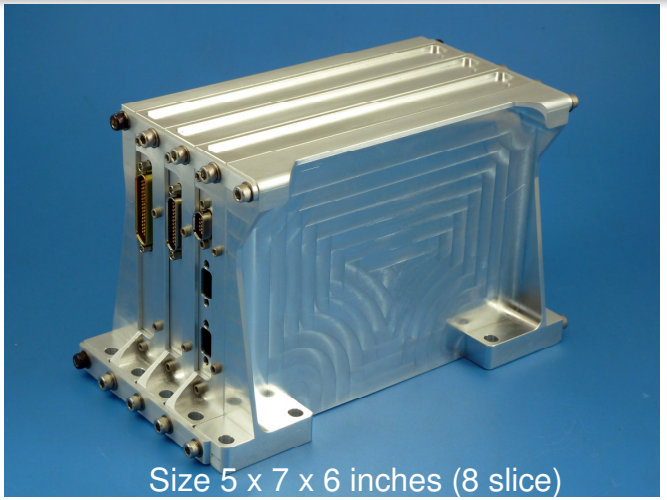


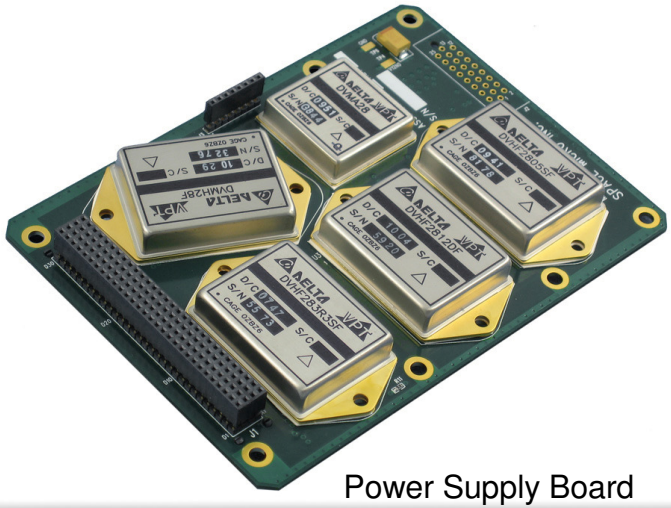
Current status and path forward

- In Phase II SBIR with AFRL
- Design nearing completion
  - Finalize all active parts & floorplan
- In progress review, next week at Space Micro
- Order any Long lead item parts and GFE parts
- Initial card fabrication, assembly, test in 3Q2011
- EM SPA-O cards release in 1Q2012
- Path forward to flight units with all rad hard ICs and space qualified (QPL) passives
- O-SAIM card fits in Proton X-box system

ProtonX-Box Avionics System

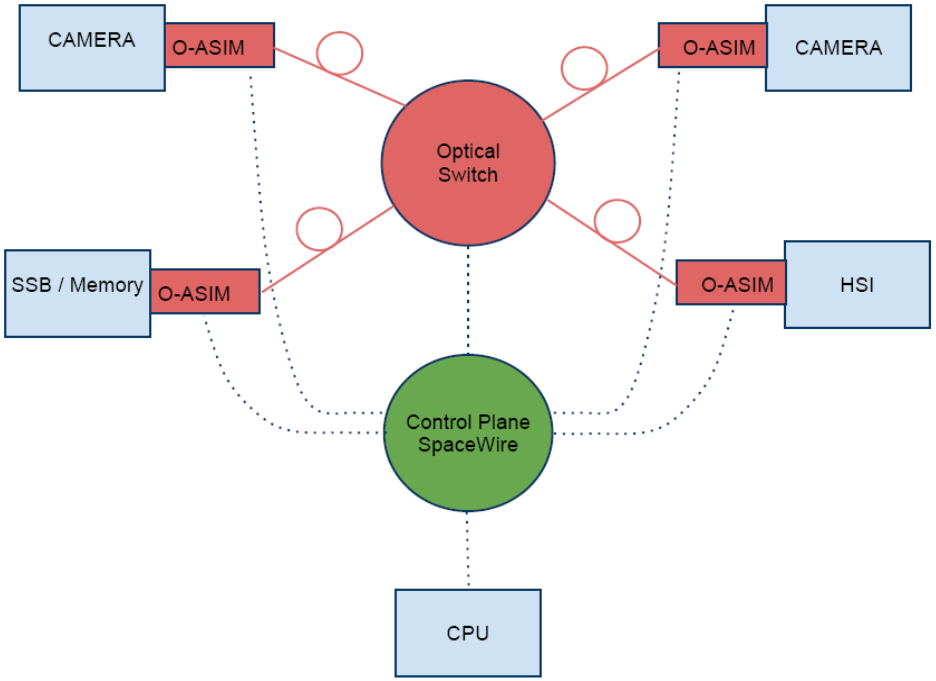
- Command, Power & Data Handling System
- Mechanically modular design (PCI-104S)
  - High number of boards can be easily connected together (>8, but potentially unlimited)
  - Industry standard 32 bit, 33 MHz PCI bus
  - Industry standard multi-drop RS-485 serial bus
  - Very small size of 5 x 7 x 6 inches for 8 boards
  - Very low mass of 3.7 kg for ten (10) boards
- Conductive cooled
- Meets shock and vibration requirements
- Meets typical space radiation requirements for 5 year LEO and GEO missions
  - >100 krad total dose
  - No SEL >70 MeV/mg/cm2 (prefer 120 MeV)
  - No unrecoverable SEFI at a system rate of 1E-2 per day
  - SEU rate of 1E-2 unrecoverable errors per day (goal 1E-3 days)
  - Auto-corrected SEU's (embedded EDAC)
  - Dose rate survivability levels of MDA-STD-001, Level 2 available


Size 5 x 7 x 6 inches (8 slice)


Power Supply Board

Conclusion

- O-ASIM provides link between SPA-O network and legacy sensors
- O-ASIM will help propel the adoption of the SPA-O systems
- O-ASIM should reduce development cycles time to meet the requirements of the ORS office



Closing thought

Thank you for your support!

SPACE MICRO