



## Promoting Aerospace Innovation through Reconfigurable Microsystems

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XRTC 2010

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## Background

**The potential positive impact of reconfigurable components on aerospace and defense systems is enormous as traditional, costly, functionally rigid system designs become increasingly challenged in meeting the needs of the 21<sup>st</sup> century.**

**Long lead times are traditionally associated with the implementation of new architectures and new technologies in the space community.**



## What Is COSMIAC?

- COSMIAC is the **C**onfigurable **S**pace **M**icrosystems **I**nnovations & **A**pplications **C**enter
- **COSMIAC is a partnership/consortium comprised of:** (\* = charter members)
  - Air Force Research Laboratory (AFRL) / Space Vehicles Directorate (RV)\*
  - Jet Propulsion Laboratory (coming soon)
  - Los Alamos National Laboratory\*
  - NASA/GSFC
  - Sandia National Laboratories\*
  - SES Consultants\*
  - Space Dynamics Laboratory
  - Southwest Research Institute
  - University of New Mexico\*
  - Xilinx\*
- COSMIAC is a congressionally supported space electronics center
- COSMIAC is the charter program of the Phillips Technology Institute (PTI) of AFRL/RV located in Albuquerque, NM
- COSMIAC's role is to promote aerospace innovation through the reliable & responsible use of configurable technology in military & aerospace systems.



## COSMIAC Mission & Vision

### **Mission:**

*To propel the use of reconfigurable electronics & microsystems in aerospace & defense systems*

### **Vision:**

*To be the Nation's Center of Excellence & specialized talent source for developing reconfigurable microsystem-based solutions for aerospace & defense applications*



## COSMIAC Services

- **COSMIAC serves the interests of Industry, Government, and Academia**
- **Thrusts include Research & Development, Education, & Outreach**
- **Services include:**
  - High-reliability FPGA design services, application development, & troubleshooting
  - Design & application guidelines for space system developers
  - Targeted R&D through structured sponsorship
  - PCB design services
  - Facilitation & oversight of technical collaborations
  - CubeSat development, demonstration, & flight opportunities
  - Rapid Prototyping & troubleshooting Radiation testing & qualification services & support
  - Talent & workforce development & placement Custom requests



## COSMIAC is Committed to SIRF & FPGAs in Space

- FPGAs offer one of our best hopes to revitalize the space industry
- We believe that there might be collaboration between the New Mexico Entities and Space Port America to provide inexpensive space access for SIRF based small satellites – commercial space may play a role in the future for launch opportunities.





## COSMIAC Believes Our Nation's Success in Space Depends on Reconfigurable Microsystems



Weather



Precision Farming



Finance



Broadcasting



Precision Navigation



Aviation



Science



Remote Sensing



Package Tracking



Communications



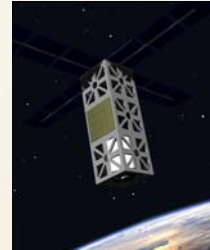
## Current Research Thrusts

- Reconfigurable Microsystems & Electronics
  - Small spacecraft as a useful substrate
  - Very high performance & compact form factor
  - Appropriate radiation mitigation
  - Active involvement with the XRTC Group
- Key activities
  - Small Form Factor FPGA-based Space Computer Board
  - NASA/GSFC SpaceCube (ver. 1.5 & MiniSpaceCube)
  - Software Defined Radio



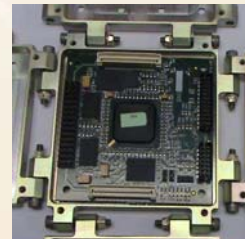
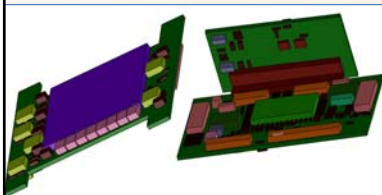
## Current Projects (1)

- CubeSatCam
  - CubeSat spacecraft design for a diffraction limited high resolution camera able to take very high quality images of earth, process those images on-board, and transmit processed images back to the ground
  - Applications include earth science, meteorology, urban and crop studies, & surveillance
  - Current system is undergoing flight testing in Cessna aircraft



## Current Projects (2)

- Compact Form Factor Space Computing
  - A fault tolerant, power efficient reconfigurable supercomputer with a 10cm x 10cm footprint
  - Applications include military, civil, & commercial space command and data handling bus functions & payload processing
  - Design path includes SIRF





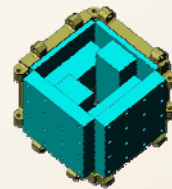
## NASA SpaceCube

- COSMIAC is working in collaboration with NASA/GSFC to advance and commercialize SpaceCube Designs
  - COSMIAC will announce the SpaceCube 1.5 (V5) Development & Commercialization Program schedule later this month
  - COSMIAC will announce the MiniSpaceCube (V5/SIRF) Development & Commercialization Program schedule later in 2010
- COSMIAC Extension FPGA Learning Lab



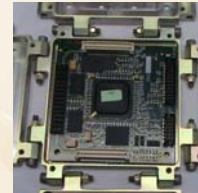
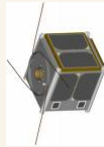
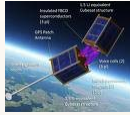
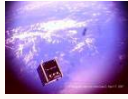
## Current Projects (3)

- Space Plug-and-Play Architecture
  - CubeFlow provides a comprehensive “rapid design modeling” framework for responsive integration of spacecraft subsystems
- Fault Tolerant Design Tools
  - Software tools to analyze & help mitigate radiation sensitivities of reconfigurable electronic systems





## CubeSat Community



### Vibrant and Growing

*Small satellites are changing the face of space related research (i.e. Space Weather, NSF Funding)*



## FPGA Courses at UNM

- 4 Courses – taught at UNM
- “Basic” skills
  - **ECE443 – VHDL for Hardware Design** (taught every Fall). Basics of the HDL with particular emphasis on interfacing the PLD to the outside world and using the PLD for advanced processing
- Advanced skills
  - **ECE595 – Hardware Security** (Taught every Fall). This course teaches issues in trust, authentication and security of hardware designs. A problem of particular importance as more manufacturing has moved overseas.
  - **ECE595 – Embedded Systems Design for FPGAs** (taught every Spring). This course is designed to teach embedded processors on the FPGA. It involves using standard and custom peripherals as well as OS implementations and the interaction of reconfigurable hardware with software.
  - **ECE595 – Advanced FPGA Design (to be developed)**: Bullet proof designers. It takes the knowledge gained in ECE443 and advances into areas such as full timing, architecture and electrical analyses, design for test, and large scale project integration.
- Optional Aerospace Skills
  - **ECE595 – FPGA Design for Aerospace** (First course Spring 10 by Dr. Quinn). This course is designed to address special requirements for use of FPGAs in air and space. This includes special reliability and testing requirements, as well as issues related to radiation effects, their mitigation and test.



# Sponsored Student Projects

- Eyad Al Zuraiqi (Dr. Christos) – Reconfigurable RF
- Brian Zufelt (undergraduate) – CubeFlow Training
- Naveen Nischal (Dr. Payman) – XTMR
- Rahul Vora (undergraduate) – CubeSat Structures and Power
- Soumik Banerjee (Dr. Payman) – Lockstep Linux
- Ryan Heliniski (Dr. Plusquellic) – Satellite Sensor Integration
- Greg Feucht (Dr. Fiero) – Adaptive Wiring
- Niranjana Kumar – Software Defined Radio



# Academic Partnerships

		
<b>University</b>		
		
		
		
<b>Community College</b>		
		
<b>K-12</b>		





## 1<sup>st</sup> Annual COSMIAC Conference



Mark your calendars: November 1-4, 2010  
Advanced Reconfigurable Space  
Microsystems

Hyatt Regency  
Albuquerque, New Mexico

Sponsorships & Exhibitor  
packages will be released



## Center Sponsorships

- COSMIAC seeks like-minded, forward-thinking organizations to participate in its Center Sponsorship Program
- ***COSMIAC provides various sponsorship packages to support the needs its member organizations***
- <http://www.cosmiac.org/sponsorship.html>



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