



# COSMIAC SIRF Briefing

August 2009



# Today's Briefing

- COSMIAC Overview
- Small Satellites
- SIRF Involvement
- COSMIAC's Projects



# About COSMIAC

- COSMIAC is a congressionally supported space electronics center and the charter program of the Phillips Technology Institute (PTi) of the Air Force Research Laboratory's Space Vehicles Directorate (AFRL/RV) located in Albuquerque, NM.
- COSMIAC's role is to promote aerospace innovation through the reliable and responsible use of configurable technology in military and aerospace systems



# Partners

- AFRL Space Vehicles Directorate (AFRL/RV)
- Xilinx Corporation
- Los Alamos National Laboratory (LANL)
- Phillips Technology Institute (PTi)
- Sandia National Laboratories (SNL)
- SES Consultants, Inc.
- University of New Mexico (UNM)



# SIRF Motivation

- FPGAs will revolutionize the way small space will be accomplished
- To reduce power consumption, you must find a way to avoid triplication of logic
- SIRF can greatly reduce power consumption by avoiding TMR



# Small Satellites/CubeSats

- Proposed in 1999 by Stanford Prof. Bob Twiggs as a picosatellite standard:
  - 10 x 10 x 10cm, ~ 1 kg maximum mass; can be combined to create multiple “U” cubes (e.g., double, triple, etc...)
- Broad acceptance, large active developer list:
  - 53 U.S. companies; 50 U.S. universities, several high schools
  - 41 foreign universities on six continents
  - 32% of papers at ‘08 SmallSat Conference were CubeSat related



CP4 (CalPoly) as seen from AeroCube-2 (Aerospace)

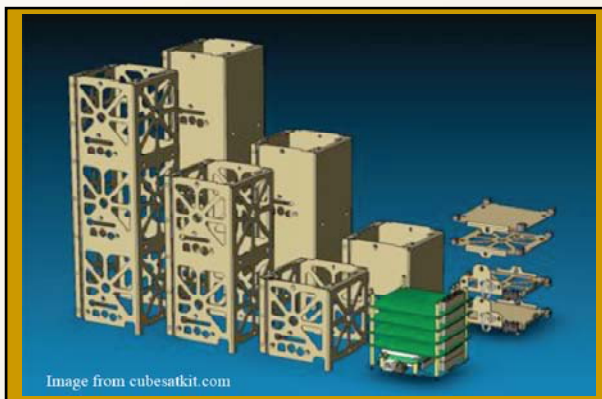
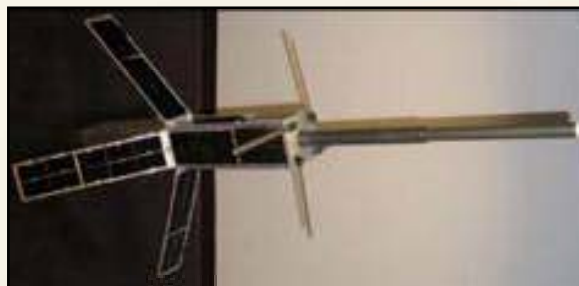


Image from cubesatkit.com



QuakeSat-1  
(Stanford University and  
QuakeFinder, LLC)



Courtesy NRO



# Practical Applications and Limitations

- Current CubeSats often provide little more than “hello world” capabilities
- DSP and Image Processing require the power of System on a Chip solutions
- Single chip solutions providing a wide range of capabilities (SDR, DSP, Encryption, PR, etc.) are in high demand
- Current power budgets for CubeSats are not sufficient for large FPGA work



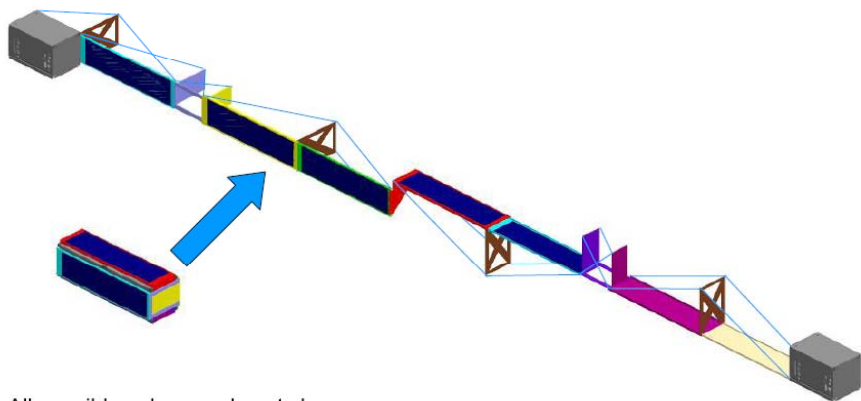


# Foster-Miller Power Solution

Large FPGA Power Requirements

Power from CubeSat Power Solutions

Back and Forth Wrapped Solid Model: Deployed



All possible solar panels not shown

## Full Structural Prototype



- 23.7 W orbital average power, 60 W peak with triple junction cells





# Application of SIRF to Small Satellites

- There is a rapidly growing demand for small satellites/cubesats
- The following organizations have solicitations for them:
  - AFRL, NRO, DARPA, NASA
- To perform complex operations that constellations of these satellites are called upon to do, reconfigurable logic is essential
- AFRLs investment in SIRF will have an immediate impact



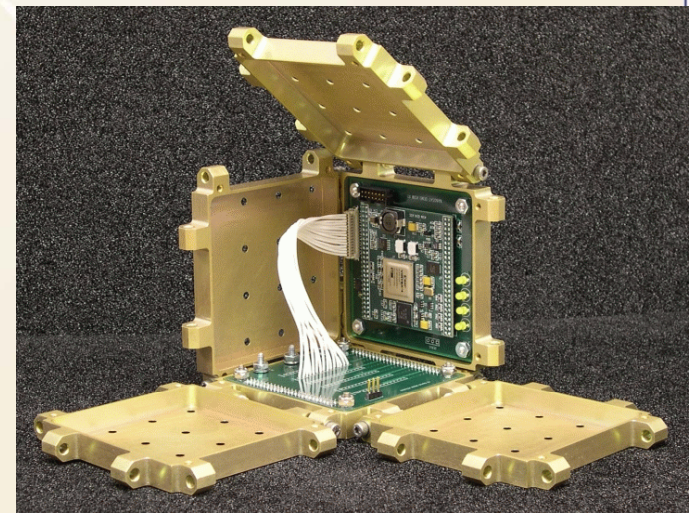
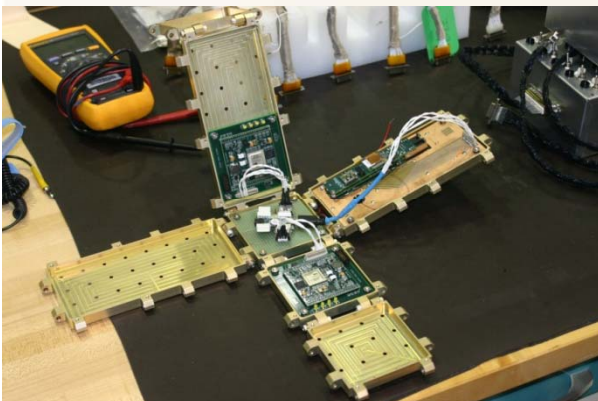
# COSMIAC Educational Activities and Services

- Training for FPGA SOC
  - Sysgen
  - EDK
  - Linux on PPC
- XTMR
  - Videos
  - Short Courses
- PCB Design
- NV Boot Rom
  - Currently working efforts with local contractor to develop solution



# Current Project

- Space Plug-and-Play Architecture
  - CubeFlow is a comprehensive “rapid design modeling” framework for responsive integration of spacecraft subsystems
  - PnP for Space has need for soft core implementation





## Current Projects (2)

- 24/7 eyes on
- 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
- First iteration being made for Spartan Family
  - First prototype in two weeks
  - Second iteration will be SIRF based



# Summary

- FPGAs will revolutionize “small space”
- SIRF will revolutionize the way FPGAs in space are accomplished
- Few individuals in the small space community know FPGAs and few individuals in the FPGA community know small satellites
- COSMIAC is ideally suited to provide the bridge that will make both work together
- Inexpensive way to get SIRF into space

***If we can make SIRF work in CubeSats, we can make them work anywhere!***