



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)

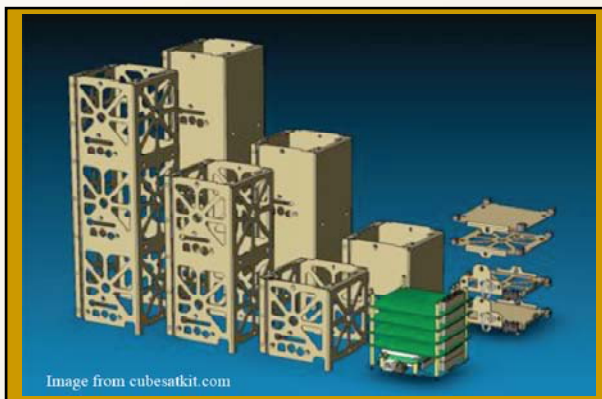
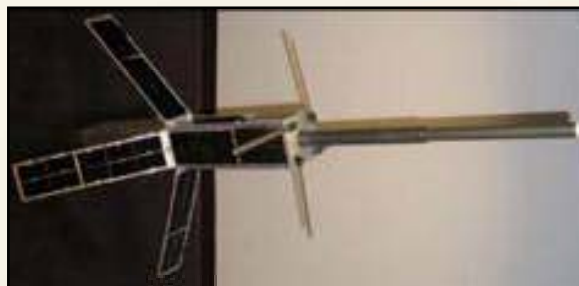


Image from cubesatkit.com



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

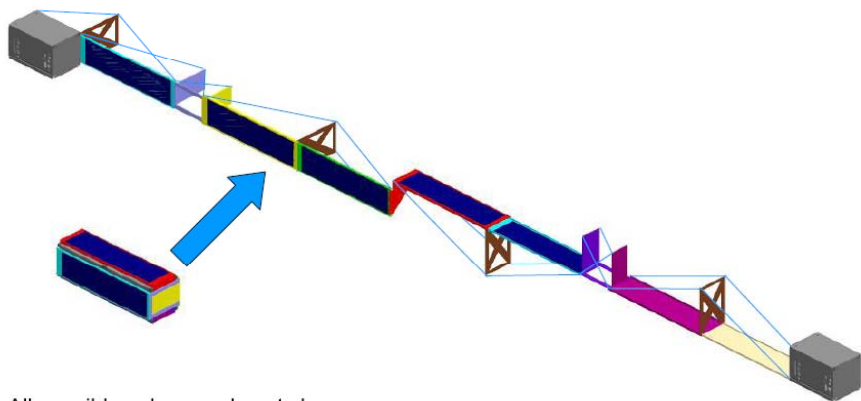


Foster-Miller Power Solution

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



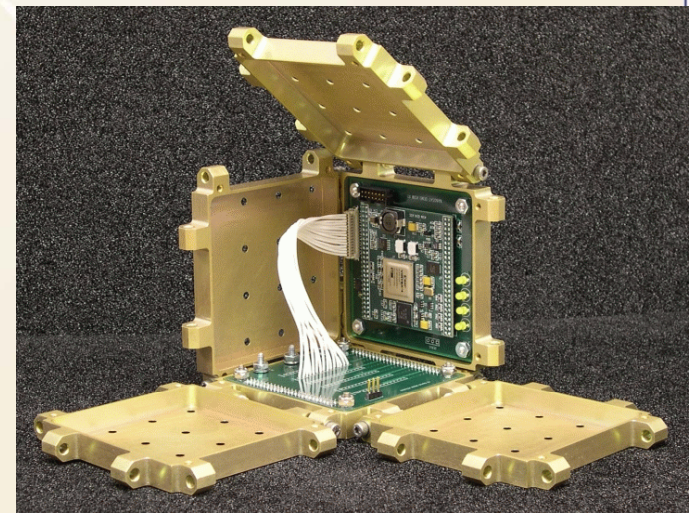
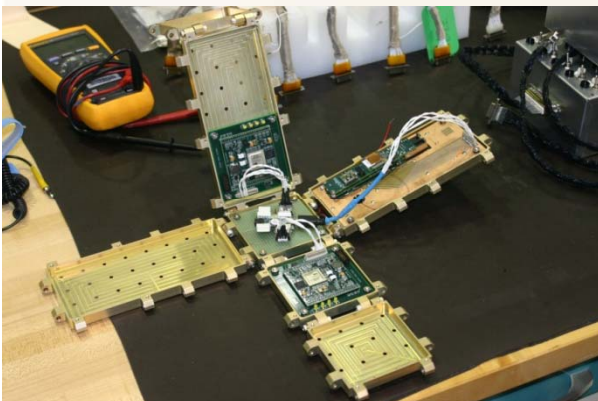
COSMIAC Educational Activities and Services

- 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!