

22nd IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Generic Technologies for Nano/Pico Platforms (6B)

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HIGH INTEGRITY SOFTWARE FOR CUBESATS AND OTHER SPACE MISSIONS

Abstract

We currently have an operating single CubeSat launched as part of NASA's ELaNa IV program November 13, 2013, the first satellite of any kind launched by a college or university in New England. Many CubeSat failures have been attributed to software failures. Of the twelve university CubeSats we were launched with, we are the only one that is fully functional. One fried their batteries the first day (a software error) and works partially only in sunlight, one lasted a week, one lasted four months and eight were never heard from. These other CubeSats primarily used the C language. We are using the most reliable software technology ever sent into space. We used the SPARK 2005 Toolset and Ada 2012 language in the construction of our software. Ada is used in almost all European Space Agency and many NASA rockets and spacecraft, most European rail systems and nuclear power plants. SPARK is used in commercial aviation (Rolls-Royce Trent jet engines, ARINC ACAMS system, Lockheed Martin C130J), military aviation (EuroFighter Typhoon, Harrier GR9, AerMacchi M346), air-traffic management (UK NATS iFACTS system), rail (numerous signaling applications), and medical (LifeFlow ventricular assist device).

We are using SPARK/Ada, with its reduction of errors by a factor of about 100 compared with C. SPARK is a formally defined programming language and a set of verification tools specifically designed to support the development of high integrity software, and can formally verify: information flow, freedom from runtime errors, functional correctness, security policies and safety policies.

Ours is the first spacecraft to use SPARK. We are currently upgrading our CubeSat software to SPARK 2014, and will then work on improving some of the algorithms in that software. We would then have a very reliable software platform, CuBOS, that other projects could use as a base for their CubeSat, or other spacecraft projects. We have also been converting NASA Goddard's GPS Enhanced Onboard Navigation System (GEONS, which will be used in our next CubeSat) to SPARK, and have discovered, and fixed errors by this process. Our next CubeSat, now in the planning stage, will be self propelled with an ion drive which we hope will go to the Moon. This software will be much more complex, dealing with GEONS, star tracker, magnetometer, gyro, radio, momentum wheels, the electrical power system and aim the photo voltaic panels and ion thruster. SPARK's reliability will be necessary for this.