50th STUDENT CONFERENCE (E2)
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BREAKING THE BARRIERS: IMPLEMENTATION OF FLIGHT SOFTWARE FOR UNIVERSITY SMALL SATELLITE MISSIONS

Abstract

The goal of this research is to present the novel work of the F Prime (F') based flight software (FSW) architecture developed for PowerSat, a technology demonstration small satellite under development at California Polytechnic State University San Luis Obispo and selected by NASA CSLI in May 2021 for a launch in 2024.

In a small satellite development process, especially for missions developed within a university, FSW can be an overlooked subsystem leading to miscommunications, misunderstandings, and longer development times. Without proper FSW, small satellites cannot execute their mission. Moreover, without repeatable FSW development processes, small satellite programs cannot implement lessons learned from previous projects and continuously improve. University-based small satellite teams face barriers, such as collective limited knowledge about asynchronous communications for concurrency, experience with designing decomposed software, availability of students to contribute to the project, and adherence to software development principles, when creating modular, reusable software. Solutions have been developed by space agencies. For example, NASA Jet Propulsion Laboratory's open-source framework, F', uses XML specifications to autogenerate structural C code enabling people with limited coding experience to contribute to FSW development . However, these frameworks, even with documentation through the F' and community GitHub websites, are still difficult to approach as a university undergraduate team due to the lack of support in the practical design and implementation of new FSW architecture for a small satellite program.

In this paper, the barriers university small satellite programs face during FSW development are identified with a focus on the experiences of first-time developers. Then, the application of the F' framework is detailed within the scope of university small satellite programs. Finally, the F' based FSW architecture developed for PowerSat is explained with an emphasis on its multidisciplinary development process, developed F' components, and publicly available accompanying development tutorials. A summary of this novel work is also discussed as a starting point for other university small satellite programs to begin developing their own FSW.

The undergraduate student research team is led by Nayana Tiwari, a fourth-year computer engineering and physics major, who works on the FSW architecture design and implementation. Additionally, Caitlin Feldewerth, a fourth-year aerospace engineering major and computer science minor, focuses on component development and tutorials. Finally, Elizabeth Hoerber, a second-year aerospace engineering student, works on attitude determination and control software. Caitlin Feldewerth and Nayana Tiwari exchange

knowledge about their specialties while mentoring Elizabeth Hoerber to create a cohesive multidisciplinary team.