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NASA Operational Simulator for Small Satellites (NOS³): The STF-1 CubeSat Case Study

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Abstract

One of the primary objectives of small satellites is to reduce the costs associated with spacecraft development and operations as compared to traditional spacecraft missions. Small satellite missions are generally able to reduce mission planning, hardware, integration, and operational costs; however, small satellite missions struggle with reducing software development and testing costs. This paper presents the case study of the NASA Operational Simulator for Small Satellites (NOS³), a software-only simulation framework that was developed for the Simulation-to-Flight 1 (STF-1) 3U CubeSat mission. The general approach is to develop software simulators for the various hardware flight components (e.g., electrical power system, antenna deployment system, etc.) to create a completely virtual representation of the actual spacecraft system. In addition, NOS³ conveniently packages together a set of opensource software packages including the “42” dynamics simulator, the spacecraft software development framework (core Flight System), and a command and control system (COSMOS). This results in a flexible and easily deployable simulation environment that can be used to support software development, testing, training, and mission operations. The NOS³ environment contributed to the success of the STF-1 mission in several ways, such as reducing the mission’s reliance on hardware, increasing available test resources, and supporting training and risk reduction targeted testing of critical software behaviors on the simulated platform. The NOS³ has been released as open-source and is available at <http://www.nos3.org>.

1. Introduction

The NASA Independent Verification and Validation (IV&V) Program's mission is to provide assurance that safety- and mission-critical software will operate reliably and safely. NASA IV&V provides this service by employing a set of documented technical methods to the customers' system and software

requirements, design, code, and tests. In 2009, the NASA IV&V Program established a simulation development team, the Independent Test Capability (ITC). The ITC team is responsible for developing and maintaining test environments that are capable of exercising mission and safety critical software. The IV&V teams are able to gain an increased

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