Key Elements of Rapid Integration and Test

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MicroSat Systems, Inc. (MSI) is currently supporting AFRL in the Roadrunner/TacSat-2 program to demonstrate the development of a tactically useful small satellite in just 14 months. This rapid development requires a flight integration schedule that is less than 4 months between flight hardware arrival and Launch Readiness Review and includes the integration of fourteen experiments and system environmental testing. This paper will review the lessons learned so far in integration and test and the key elements for success in the rapid development process. Management of I&T activities is a critical component in rapid development. Flexible scheduling in complex missions with very short time frames is the key to efficiently using test time. To adapt to the often fluid schedule requirements of I&T, it is necessary to have several options for activities the test team can perform at any given moment. Therefore when Component A runs into problems, Components B, C, or D can be tested during the originally scheduled time with no net impact to schedule. To achieve this objective multiple items must be ready ahead of schedule and several different teams need to work in parallel preparing future tests, debugging troublesome equipment offline, and conducting tests in the test environment. Automated or computer script-driven testing adds tremendous flexibility to the process. By capturing the specific technical expertise for a particular test in the script, any reasonably familiar operator can execute the test, allowing for different experts to work on multiple items. This approach has provided the Roadrunner program enough flexibility to have as many as six different test teams each in various stages of test preparation, execution or documentation. This large number of teams allows for testing in multiple shifts and across an extended workweek, as some teams can have down time while the other teams are working. The use of scripts decouples specific people from specific tests to allow the critical debugging work to happen offline while other testing continues uninterrupted. Script-driven testing also makes handoff to flight operators easier by providing a knowledge bridge between groups. A key element to rapid testing is a streamlined documentation system that efficiently captures requirements, test knowledge, problems, standard procedures, and verification status without unduly burdening the test teams. To this end, the Roadrunner team uses a minimal set of documentation including a daily test log, a simple Problem/Failure database, an Excel verification matrix, simplified test procedures and "Test Flows", which are brief documents that tie requirements to scripts and set the framework for the test.

I.   Introduction

MICROSAT Systems, Inc. (MSI) is supplying the spacecraft bus for the Air Force Research Laboratory's (AFRL's) Roadrunner mission. This mission is also known as TacSat-2 and officially as the Joint Warfighting Space Demonstration-1 (JWS-D1). This mission is attempting to radically streamline the development process for spacecraft, reducing traditional two to three year small satellite development to just fourteen months. The JWS-D1 mission incorporates fourteen experiments, adding significantly to the integration challenge.. This type of accelerated schedule requires a radical reduction in I&T time to just a few months. MSI's role in this process has been to conduct the I&T of the spacecraft bus and to support the work of Jackson and Tull (J&T) who is responsible for I&T of the entire spacecraft including payloads as shown in Figure 1.

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