IAF SPACE SYSTEMS SYMPOSIUM (D1)
Lessons Learned in Space Systems: Achievements, Challenges, Best Practices, Standards. (5)

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BEST PRACTICES ON ADOPTING OPEN-SOURCE AND COMMERCIAL LOW-COST DEVICES IN SMALL SATELLITES MISSIONS

Abstract

The NewSpace approach of utilizing CubeSats and smaller satellites for complex LEO missions that once were reserved only to bigger platform, paired with the requirement of enduring reliability and quality assurance on batches of tens of satellites, is paving the way for the use of commercial-off-the-shelf (COTS) components in micro-satellite missions. The recent global supply chain issues and extended lead times in the procurement of micro-controllers, memories and passive electronic components, caused by the pandemic and factories shutdowns, have resulted in a forced procurement diversification of several key elements, even in partially assembled products. GAUSS has been designing, manufacturing, and launching Small Satellites since early 2000. Its tenth satellite, UNISAT-7, was launched by a Soyuz-Fregat LV on March 22nd, 2021. Thanks to the vast experience gained on the application of commercial components in all the subsystems developed by the company, the typical overall costs for a complete platform are substantially lower compared to competitors, while retaining similar reliability. UNISAT-7, developed using lean-satellite methodologies, included more than 28 independent subsystems with their own telemetry, and most of them were developed in-house using ground COTS components; no space-grade products were employed, to save on overall mission costs. Some systems were devised from the start using open-source hardware, to expedite the prototyping process, while having the benefit of using readily available software, generally included with these platforms. Raspberry embedded devices were employed on the flight model for two remote sensing systems, to test how such systems, duly adapted to sustain space conditions, may perform and show reliability similar to commercial space systems worth thousand times the value. UNISAT-7 included a Raspberry 3B+ and a Raspberry Zero W, COTS refractive lenses, general-purpose real-time clocks and inexpensive USB-UART adapters acquired from global online retailers, commercial SD cards, and all GAUSS subsystems typically use automotive- or critical-level COTS items. All systems have been activated and successfully verified for an entire year in LEO. They were hardened for vacuum, extreme temperatures, radiation and launch stresses using common items found in general hardware stores, like two-components epoxy adhesives and metal tape. When original shielding elements were not available, custom-developed aluminum frames were employed to protect the most sensitive devices, like lens assemblies and CMOS elements. This work will delve into the open-source / COTS components used, the process employed to strengthen them, and the programmed flight firmware routines for maximizing embedded devices' reliability in space.