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Author: Mr. Jan-Gerd Meß
Deutsches Zentrum für Luft- und Raumfahrt, Germany, jan-gerd.mess@dlr.de

Prof. Matteo Sonza Reorda
Politecnico di Torino, Italy, matteo.sonzareorda@polito.it
Prof. Massimo Violante
Politecnico di Torino, Italy, massimo.violante@polito.it
Dr. Frank Dannemann
German Aerospace Center (DLR), Germany, frank.dannemann@dlr.de
Ms. Berenike Hanson
AAC Microtec, Sweden, berenike.hanson@aacmicrotec.com
Mr. Niklas Karlsson
AAC Microtec, Sweden, niklas.karlsson@aacmicrotec.com
Mr. Tobias Kuremyr
AAC Microtec, Sweden, tobias.kuremyr@aacmicrotec.com
Mrs. Stefan Söderholm
Sweden, stefan.soderholm@aacmicrotec.com
Mr. Yann Albert
ArianeGroup, Germany, yann.alber@ariane.group
Mr. Joachim Spiecker
ArianeGroup, Germany, joachim.spiecker@ariane.group
Prof.Dr. Görschwin Fey
Technische Universität Hamburg (TUHH), Germany, goerschwin.fey@tuhh.de

MASSIVELY EXTENDED MODULAR MONITORING AND A SECOND LIFE FOR UPPER STAGES

Abstract

Launching science and technology experiments to space is an expensive issue. Although commercial spaceflight has resulted in a drop of prices, the cost for a launch is still significant. However, most of the weight that is needed to conduct experiments in space belongs to the spacecraft's bus and is responsible for power distribution, thermal management, orbital constrol and communications. Although strictly necessary, these systems seldomly contribute to the scienfitic output of a given mision and still have to be purchased and launched. An upper stage, on the other hand, includes all the necessary subsystems and has to be launched in any case. Many upper stages (e.g. ARIANE5) will even stay in orbit for several years after their nominal mission with all their subsystems intact but passivated.

To further reduce launch cost, we describe a system concept that allows cost-efficient launching of technology experiments by reusing the launcher's upper stage and its subsystems. Inhaling a second life to an upper stage by adding a secondary mission makes use of subsystems already in orbit that would otherwise become space debris.

To justify the extra weight of this system, acquisition channels for various sensors can be added. This gives the launch provider the ability to flexibly place additional sensors on its launcher providing deeper insight into its mechanical stress and environmental conditions. The payload bus can be used to acquire

valuable data during the launcher's nominal mission. Exploiting the computational power of the COTS hardware, intelligent and mission-dependent data selection and compression are applied to the sensor data. This enables a high information throughput even at low data rates that can be integrated in the existing launcher telemetry. This provides a substantial benefit to the launch provider. Thus, such a payload bus could be used very efficiently throughout the mission by providing valuable data to the launch provider and orchestrating the payload(s).

In this paper, we demonstrate the implementation and qualification of a high-performance payload bus system based on commercial-off-the-shelf (COTS) components inside a protective container that offers a well-defined and safe interface shielding the launcher from malfunctions of a payload and protecting the payload(s) from the harsh environment on board the launcher. At the same time, the system is minimally invasive to the launcher and its nominal mission. The reliability of the COTS-based system is improved by adding radiation hardening techniques and software-based self-test detecting and counteracting SEEs during the mission.