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INTRODUCTION OF A NEW SANDBOX INTERPRETER APPROACH FOR ADVANCED SATELLITE OPERATIONS AND SAFE ON-BOARD CODE EXECUTION

Abstract

CubeSats evolve from pure teaching resources towards platforms for scientific research and technology development. Especially formations of small satellites are gaining increasing attention in the area of temporal or spatial coverage and resolution demanding missions. In this context, the University of Wuerzburg and the Zentrum für Telematik develop CubeSats with the objective to establish a formation of cooperating distributed small satellites within this decade. The University of Wuerzburg has launched its third CubeSat UWE-3 in end of November 2013 and is since then operating the satellite to perform real-time attitude determination and control experiments. With UWE-3 a new modular and flexible satellite bus was introduced which has now been extended onto the software.

The aspired software concept had to fulfil several requirements: small footprint, deterministic memory consumption, fast exchangeability of code fragments, testability, safe and interruptible code execution. For that purpose a new Tiny interpreter language has been defined and implemented. The software solution consists of two essential parts: the TinyIDE development environment and an interpreter for C. The script is composed, compiled and debugged within the IDE. The compiled bytecode is transmitted to the target system where it is executed in a sandbox environment. That is: only predefined system functions can be invoked, illegal memory areas are inaccessible and the execution can be paused any time. During the offline tests a Matlab bridge can be utilized to emulate the answer of the system functions. The upcoming Tiny extension will introduce cooperative/cluster computation by automatic distribution of code fragments along multiple satellites and combining the answers afterwards.

The software on board of UWE-3 has been updated to support the described scripting language on two of the satellite's subsystems. For the OBDH it adds value as a high level mission operation software, however, especially in the context of the attitude determination and control system it has extensively been made use of the flexible software concept. The inherent support for frequent but small software updates facilitates and accelerates the development and test of new control algorithms. This is not only in favor for future satellite missions but will also further be employed in the teaching domaine. Students will be given a clear interface to the satellite and can perform their experiments without much effort within a safe environment.