24th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Highly Integrated Distributed Systems (7)

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LEAN HARDWARE UPDATE PROCESS FOR A MODULAR SATELLITE PLATFORM

Abstract

Small satellites, such as nano- or microsatellites offer great potential for efficiently implementing distributed space systems at comparatively low costs. In this context, minimizing mission development times, while at the same time maintaining a high level of reliability are key requirements for state-of-the-art spacecraft. This is commonly approached by reusing heritage from former missions. However, such satellite platforms usually utilize components from the information and communications technology (ICT) as well as the automotive industry to achieve the aspired performance. As these industries are introducing new technologies in comparatively short cycles, developers need to frequently replace outdated components by more performant versions in order to maintain a competitive design. Within the development of its modular nanosatellite platform TUBiX20 currently applied for the two missions TechnoSat and TUBIN, Technische Universität Berlin introduced a design approach that minimizes the effort required to replace dedicated components in a given design and thus facilitates capabilities for continuous hardware updates. Electronic units are further divided into functional blocks that can clearly be associated to one specific function on the reasonably smallest level. An on-board computer for example may contain, among others, a microcontroller, external memory and latch-up protection circuits, which are here treated as individual blocks. This approach offers two distinct advantages: Firstly, the segmentation into designated functional units effectively restricts the complexity of the single block. This in turn, simplifies functional verification and environmental qualification. Secondly, one or more blocks can easily be isolated and replaced with newer versions of improved performance or even extended functionality without affecting adjacent parts. Similarly, new hardware is built from a pool of existing blocks already used in other designs as well as newly introduced ones. The individual blocks are designed following a test driven development approach borrowed from the software domain. After the aspired range of functions is defined, each block is individually designed and produced as discrete, fully configured hardware board. At the same time tests are implemented in software, which are then used in hardware-in-the-loop tests to confirm that all requirements are met. The same setup is then used for qualification, i.e. in environmental tests such as thermal-vacuum or total ionizing dose tests. In summary, this hardware design process allows for continuously introducing new, innovative technologies into a given design, while at the same time effectively limiting the required effort.