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THE VIRTUAL TESTBED APPROACH TOWARDS MODULAR SATELLITE SYSTEMS

Abstract

Within the iBOSS project (intelligent Building Blocks for On-Orbit Satellite Servicing and Assembly), a concept for modular satellite systems is developed. The multidisciplinary concept is based on building blocks (iBLOCKs), providing a mechanical structure for the integration of electronics and payloads, a distributed hard- and software architecture and finally a multi-functional 4-in-1 interface (iSSI) connecting the building blocks (mechanical connection, electrical power connection, data connection, thermal connection).

Modular satellite systems require sophisticated thermal architectures, novel computation concepts, distributed operational software architectures and have high requirements towards structural dynamics. Additionally, standardized modular satellites systems offer robotic servicing capabilities, enabling reconfiguration, maintaining and upgrading operations, which sustainably and cost-efficiently extend the lifetime of satellites and reduce space debris. Due to this immense amount of interdependencies, iBOSS-based satellite systems constitute a great challenge, regarding the design of these systems.

To face all these interdisciplinary challenges, the Virtual Testbed iBOSS (VTi) is developed within the iBOSS project. The Virtual Testbed iBOSS combines state-of-the art simulation algorithms, e.g. rigid body dynamics, orbital dynamics, sensor simulation algorithms, solar input radiance simulation, as well as interfaces to FEA simulation and thermal simulation. Furthermore, the Virtual Testbed iBOSS provides interfaces to control algorithms and the operational software of the satellite, and thereby facilitates the simulation of comprehensive Digital Twins of the real space systems. Based on the Digital Twins of

iBOSS-based satellite system, the Virtual Testbed iBOSS provides a holistic simulation and development tool, supporting the development of modular satellites right from the beginning. One important aspect are the new concepts for simulation-based verification and validation.

In this paper, the authors present the key simulation technologies forming the base for the new simulation-based verification and validation concepts. The benefit of simulation-based verification and validation approach within iBOSS project is outlined and applications of simulations on systems level are presented. The intuitive design and simulation-based analysis of iBOSS based satellites is demonstrated and the sustainable value of the simulation technology for the development, validation and verification of modular satellite systems is emphasised.