SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and Development (1)

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BUILDING BLOCK-BASED "IBOSS" APPROACH: FULLY MODULAR SYSTEMS WITH STANDARD INTERFACE TO ENHANCE FUTURE SATELLITES

Abstract

Modular concepts and standardization of space infrastructure have been investigated for decades, while modular systems and standard interfaces have not become reality yet, despite promising outlooks and impressive technological developments. This paper outlines some generic context of spacecraft modularity, standardization and OOS regarding a modular system approach. An integrated view on these issues is given based on the "iBOSS" project (**i**ntelligent **B**uilding Blocks for **O**n-Orbit **S**atellite **S**ervicing) funded by the German Aerospace Center DLR and centers around two key elements: modules consisting of both, structural and functional elements and a standardized 4-in-1 interface for docking, power, data and thermal interconnection. The iBOSS approach presented opens up new perspectives for modularization of future satellite systems. This includes not only the possibility for servicing spacecraft in orbit, but also enhancement and substitution of common in-orbit infrastructure elements. Using prequalified, "off-the-peg" modules with interfaces, a rapid development on demand of efficient iBOSS-based "iSats" and other flexible space systems is possible. The modules can come in different quality classes defined by the performance of integrated components and opt for selection based on envisaged mission profile, orbit and lifetime. Previously defined requirements regarding modularity and standardization demand unique and complex boundary conditions for the design of the satellite's structural architecture. Throughout the development process the design of the module structure and its interfaces was continuously evolved and improved with the goal of increasing functionality, performance and reliability while decreasing mass and complexity. The main challenge for the development of the interface mechanism is to integrate a highly functional system into very limited building space, which is necessary to keep the overall module dimensions within reasonable margins. The design of the mechanical interfaces is accompanied by experimental evaluation of their suitability for robotic manipulation, which is a key capability for robotic

servicers. To reduce the requirements on precision of interface and the robotic servicing, we investigated visual localization and force based guiding of the robot motion. Automatic planning systems reduce the operator's effort in a servicing mission. To exploit modularity in the design process, computer aided satellite design is investigated. Based on task specific requirements, modules are automatically selected from a catalog to plan an appropriate satellite configuration. This may simplify the design process in the long term enabling a non-expert to create a satellite.