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"IBOSS – MODULAR BUILDING BLOCK APPROACH TOWARDS MORE FLEXIBLE AND EFFICIENT FUTURE IN-ORBIT INFRASTRUCTURE"

Abstract

Modular concepts and standardization of space infrastructure elements have been investigated for decades, while building block systems and standard interfaces have not become a reality yet.

Efforts were initially driven by space robotics and envisaged on-orbit servicing (OOS) principles to embark on maintainability, more efficient design and operation of future space systems. Despite promising outlooks and impressive technological developments neither full demonstrations nor routine operations have become part of today's space activities.

This is partly due to funding issues alongside with political justification problems of relevant programs. Shortfalls are - besides often too complex technical solutions - lacks in end-to-end considerations beyond technology, respectively in understanding implications of long-term economic impacts and associated feedback to technology development.

The paper outlines some generic context of spacecraft modularity and standardization, OOS, on-orbit assembly (OOA) and active debris removal (ADR) both regarding generic technology principles and associated economic factors in particular. An integrated overview on the "iBOSS" project (Intelligent Building Blocks for On-Orbit Servicing) backed by the "German Aerospace Center DLR - German Space Administration" is provided to assess economic and other non-technical factors. iBOSS is centered around two key elements: a standard 4-in-1 interface (mechanical, thermal, power and data) and standard cubes (structural and functional elements) enabling for flexible and efficient (iBOSS-based) "iSats" and other new and flexible space systems in the mid-term. Effects on potential cost savings i.e. economy-of-scale effect and other benefits are described.

In order to handle the technical complexity and to bridge the gap between technical and economical requirements and impact, iBOSS scenarios are modeled in a comprehensive virtual test bed. With combined virtual reality and 3D simulation techniques, both the potential and limits of modular systems and options for their robotic manipulation in space can be explored and demonstrated. This supports communication with decision makers in government and industry organizations by integrating technical with economic arguments.

Background of the findings presented are combining experiences made by the authors over decades of involvement in space projects and commercialization, space robotics and simulation, venture capital, angel finance, business incubation, education, international partnerships and strategy development on global level with space systems engineering principles and findings of the iBOSS project over the last 5 years.