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MAINTENANCE AND SUSTAINABILITY IN ORBIT: MODULAR STANDARD FOR THE NEW GENERATION OF SATELLITES

Abstract

The increasing reliance on satellites for scientific, commercial and defense applications require a paradigm shift in design and maintenance strategies. In particular, current CubeSat architectures lack structure modularity to make in-orbit repairs and upgrades. This paper proposes a standardized modular construction protocol for CubeSats, allowing for component replacement and maintenance directly in space. The proposed structure envisages CubeSats as interconnected functional modules, facilitating the removal of damaged units and the integration of upgraded components, thus extending mission duration and reducing space debris.

This paper outlines the development of a universally accepted standard for the modular assembly of CubeSats that requires international collaboration between space agencies, industry players and research institutes. This protocol will enable interoperability between modules from different manufacturers and nations by defining uniform physical and communication interfaces. The framework could also serve as a basis for future applications in larger spacecraft, supporting the evolution of in-space manufacturing and in-orbit servicing.

To reach the aim of this paper, a Model-Based System Engineering approach is pursued. This study is carried out in the framework of the Space Exploration and Development Systems XVII (SEEDS XVII) II Level Master's programme, a project born from the collaboration between the Politecnico di Torino (PoliTo), the Institut Supérieur de l'Aèronautique et de l'Espace (ISAE) and the University of Leicester, with the participation of Agenzia Spaziale Italiana (ASI), Centre National D'Etudes Spatiales (CNES), European Space Agency (ESA), Thales Alenia Space and Altec.