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ON-ORBIT TECHNOLOGY DEMONSTRATION AND VALIDATION: METHODS AND TOOLS FOR MISSION, SYSTEM AND OPERATIONS DESIGN.

Abstract

The paper deals with the description of a methodology to properly perform space mission analysis and design, with particular attention to innovative technology demonstration/validation missions. Future human exploration programs point towards new and more challenging objectives, which require the development of new advanced systems and technologies. A system is considered flight-qualified if it has completed a demonstration mission in space environment. A general methodology for the analysis of in space demonstration/validation missions has been developed and all the relevant steps have been defined. The very first design step is Mission Statement and Objectives definition. A parallel activity is the stakeholders' expectations analysis, mainly based on identifying all mission's actors and their expectations, thus deriving additional objectives. The following step in the design process is the Requirements Definition. It derives from the interaction with Functional Analysis and Concept of Operations (ConOps) analysis. The Functional Analysis allows identifying physical components needed for mission's accomplishment. The ConOps analysis has the main scope of describing how the system is operated during life-cycle phases to meet stakeholders' expectations. The combination of these analyses allows assessing main mission and system requirements, which are then used for system architecture and budget evaluation. The process relies on the use of specific software tools, which provide useful means for the analyses integration giving also the chance to easily track and verify the results. The paper reports a detailed description of the methodology, as well as an example case study in order to provide a clearer understanding of the entire process. The analysed case refers to on-orbit validation of inflatable technology, which indeed is one of the most significant technologies to be developed for future human space missions to deep space targets. The demonstration mission is defined in details, with particular attention to operations, which indeed represent a crucial point for the execution of the tests for the inflatable in-orbit demonstration. Specifically, the reference mission relies on the exploitation of the ISS, where the inflatable demo is brought as part of a larger spacecraft, which also includes a propulsive service module and a rigid pressurised cargo module.

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