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SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Architectures (4)

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COMPARING AND OPTIMIZING THE DARPA SYSTEM F6 PROGRAM VALUE-CENTRIC DESIGN METHODOLOGIES

Abstract

The Defense Advanced Research Projects Agency (DARPA) System F6 (Future, Fast, Flexible, Fractionated, Free-Flying) Program has the long-term objective of demonstrating that monolithic spacecraft can effectively be replaced by a set of smaller spacecraft modules, that is, a fractionated spacecraft. Conceptually, fractionated spacecraft consist of a set of physically independent, "free-flying" modules that each collaborate on-orbit to collectively achieve a certain level of system-wide functionality. Four major aerospace companies each developed distinct computer-based simulation models to quantitatively compare the risk-adjusted net value of a monolithic to a fractionated spacecraft. These have notionally been called value-centric design methodology (VCDM) tools and a publicly available version of all four tools was released at the end of the development period. This research effort seeks to further the efforts of the development of the VCDM tools in two main areas. First, a quantitative comparison between the four tools will be made through the assessment of roughly a dozen fractionated spacecraft architectures. Because of the diverse nature of the four VCDM tools, the analysis exercise will, as much as possible, ensure the inputs to the VCDM tools are kept constant to provide the fairest comparison of their respective outputs. The specific contributions of this element of the research effort are contended to be a succinct, quantitative comparison of the VCDM tools and also the provision of prescriptive insights for the improvement of the System F6 Program's VCDM development effort. The second constituent of the research entails an application of a multiple disciplinary optimization (MDO) methodology to the PIVOT tool, which was chosen to continue into the next phase of the System F6 Program. Specifically, a MDO methodology will be embedded in the PIVOT tool and thereby used to determine the optimum fractionated architecture. The outcome of this aspect of the research is the provision of useful insight regarding the optimum number of modules, technology usage (or lack thereof), and orbital/mission parameters. In turn, this information may lead to a few "best practices" or heuristics for designing, at least conceptually, fractionated spacecraft. In holistically examining this research effort, it stands to make two unique contributions. The first contribution is a robust quantitative and qualitative comparison of the four DARPA System F6 VCDM tools. The second contribution is the formulation of prescriptive insights as to optimal architectural (compositional) strategies for fractionated spacecraft, in terms of perceived value and other system objectives.