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14TH IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Space Technology and System Management Practices and Tools (4)

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GAMESPACE EXPLORATION PROCESSES FOR DECENTRALIZED SPACE SYSTEMS ENGINEERING

Abstract

This paper presents an application of gamespace exploration for the study of decentralized design processes in space systems engineering. Complex space system projects such as robotic exploration missions and human spaceflight infrastructure are often developed in collaboration between multiple organizations and countries, and involve the intertwine of different design disciplines. In such projects, design authority is coordinated yet remain decentralized among multiple decision authority. While design theory often assumes a central systems engineering authority setting requirements and allocating budgets to different design disciplines, many projects are instead developed by multiple design entities and coordinated so that to achieve common goals. Peculiar design decisions are often the result of distributed design authority; consider for instance the presence of two different water treatment and distribution systems, and two different electrical power standards operating onboard the International Space Station.

The goal of this paper is to address decentralized design processes in space systems engineering, and demonstrate the application of gamespace exploration to shed insights on such design practice. Gamespace exploration theory has been recently proposed by the authors as a tool combining game theory and tradespace exploration to assess the effects of decentralization in engineering systems architecting. The paper applies gamespace exploration to a decentralized design process of a satellite-controlled microgrid infrastructure, and reveals insights on how to effectively manage the allocation of decision authority among distributed design teams.

The case study illustrated in the paper shows how design inefficiencies may be potentially introduced by suboptimal allocations of design decisions, and defines guidelines for the application of the methodology to space system design studies in other contexts. The paper will thus be of value to systems engineers concerned with the design of space system projects developed in international collaboration and under distributed design authority in general.