IAF SPACE SYSTEMS SYMPOSIUM (D1)
Space Systems Engineering - Methods, Processes and Tools (1) (4A)

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TECHNOLOGY ASSESSMENT AND PRIORITIZATION FOR SPACE ARCHITECTURES

Abstract

The size and complexity of space architectures, the large number of disciplines involved in the design of space missions, and the uncertainty in prediction and assessment of required research and development pose a severe challenge on medium- and long-term planning. Often, the cost of space missions exceeds the estimated budget and deadlines need to be pushed back. Various features of space architectures and space mission design explain the difficulty in modeling and analyzing their cost, schedule, and risk. First, interactions between the involved systems and technologies cannot be easily identified. Second, the diversity of participating stakeholders and involved disciplines, and the multiple sources of information make the trade space large and difficult to navigate and analyze. Third, continuous progress in the field leads to the development of new technologies, for which data and models are likely to be scarce, thus contributing to increase the uncertainty.

Previous research in System-of-Systems focused on modeling and analysis of interactions between systems in the operational domain, to identify risks and criticalities. We propose to apply similar methodologies to interactions between technologies in the developmental domain, with the goal of identifying potential bottlenecks and risks in the schedule of space missions. This approach supports decision-making for prioritization of technologies, accounting for technological needs of the mission, uncertainty in development time, and potential delays. However, building models to use System-of-System tools requires collection of appropriate data, which is not always readily available. To overcome this obstacle, we implemented and trained artificial intelligence agents that can recognize information coming from multiple sources, including documents in plain English. The agents can evaluate the relevance of documents for which they are trained, as well as recognize useful information in publications which are not strongly connected with the specific technology on which the agent has been trained. For use within the System-of-Systems analytical tools, the research can be refined with the use of keywords, that provide the capability of identifying complex information as required by the tools.

In this work we describe the use of artificial intelligence agents and System-of-Systems methodology to prioritize Cryogenic Fluid Management technologies in an Artemis-based mission to the Moon and beyond. We illustrate how the agents can facilitate the acquisition of the necessary data to feed the System-of-Systems tools and discuss current and future steps in this approach.