Paper ID: 57026
student

27th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Virtual Presentations: 27th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (VP)

Author: Mr. Vlad Dragos Darau
University of Vigo, Spain, vdragos@uvigo.es

Prof. Fernando Aguado Agelet
University of Vigo, Spain, faguado@uvigo.es
Mr. Alejandro Camanzo
University of Vigo, Spain, acamanzo@alumnos.uvigo.es

MODEL BASED SYSTEMS ENGINEERING APPLIED TO AEROSPACE SYSTEMS OF SYSTEMS

Abstract

Model-Based Systems Engineering (MBSE) for Systems of Systems (SoS), or SoSE, is a novel paradigm that addresses complex project management involving multiple systems families. It uses data models to exchange information, as contrary to the traditional Systems Engineering, that relies mainly on documentation.

It is necessary to create a standardized way of applying SoS MBSE concepts that reduce mission costs, risks, human errors, and increase operability, design performance, and requirements traceability in the space engineering industry. It is currently a joint effort of different space agencies: ESA, NASA, and JAXA, as well as different governments and passive stakeholders like INCOSE, IEEE, ISO. Also, among the academic community, there is a CubeSat mission reference architecture model under development, along with various tools offered by commercial enterprises. Despite this effort, due to low technology maturity, industry acceptance stays relatively low by 2020.

Our objective is to standardize the SoS CubeSat mission implementation and management by applying the MBSE paradigm to design and implement a well-defined set of methods, processes, and tools within a dedicated framework.

We chose one of our previous missions as a reference mission involving SoS, where systems engineering was applied: The FIRE-RS Mission. This mission is a fire detection and mitigation SoS. We reformulated it in terms of MBSE concepts by creating a FIRE-RS system model that replaces the documented key design drivers of the SoS in several steps. We started by considering applicable Requirement Engineering standards at a system level and performed a reclassification of the mission requirements in a way that integrates into a complete SysML Requirement Model. Then, we address the seven challenges formulated by INCOSE when dealing with SoS to classify and model requirements at the SoS level, focusing on assuring the traceability when dealing with heterogeneous systems. The resultant Mission Requirements Model shall be validated via defined global model constraints and used as an input for the budget analysis module. At this point, a functional architecture that satisfies the model up to a defined dynamic margin is produced as an MBSE artifact. From the functional architecture, an assessment of mission design performance is made by comparing crucial technical and stakeholder design constraints when systems engineering is used, and when MBSE SoS is applied. Finally, the differences in terms of cost, risk mitigation, and design feasibility are assessed to provide objective data with respect to the gain obtained by applying the proposed SoSE standard framework.