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MODEL-BASED SYSTEM ENGINEERING TO LEVERAGE GROUND SEGMENT DEVELOPMENT OF SPACE MISSIONS.

Abstract

Model-Based Systems Engineering (MBSE) is a modern method, and it is applied in the development of aeronautical, automotive, and space systems. The adoption initiatives of MBSE by major space agencies, such as National Aeronautics and Space Administration (NASA) and European Space Agency (ESA), in their space program and missions highlights the importance and evolution of this method. Several entities, in addition to INCOSE, such as the Object Management Group (OMG), the European Cooperation for Space Standardization (ECSS), and Consultative Committee for Space Data Systems (CCSDS) collaborate with these initiatives. In the space missions, the ground segment must meet the requirements defined by the space segment in the early stages of mission development and ensure synergy between these segments. In this setting, the ground segment is often considered a ready-to-run system; however, during mission evolution, new requirements, which become new functions, may be requested for the ground segment. In this context, new issues need to be addressed and additional analysis applied to meet the cost requirements, reduction development time, and the Assembly, Integration and Testing (AIT), as well as the contribution to systemic solutions with modern development methods. The paper proposes a system architecture for ground segment employing the MBSE to support its formal design description. As background, it presents an overview of the Scintillation Prediction Observations Research Task (SPORT) mission, which aims to explore the preconditions leading to the equatorial plasma bubble and improve the understanding the conditions that leads to scintillations. SPORT mission is an international partnership between NASA and the Brazilian Space Agency (AEB). Through NASA, American universities and the Aerospace Corporation provide the scientific instruments. Through AEB, the Technical Institute of Aeronautics of the Command Department of the Brazilian Air Force (DCTA/ITA) is responsible for developing the spacecraft, and National Institute for Space Research (INPE) is charge for the development of the ground segment, planning and operation, and data dissemination, as well as providing support for the SPORT satellite's AIT in the Integration and Test Laboratory. This paper describes ground segment of INPE including the Ground Stations for Tracking and Control, the Reception and Recording Stations, the Satellite Control Centre, and the Brazilian Monitoring and Study of Space Weather (EMBRACE) in the light of the MBSE method. This solution aims to improve methodologies to optimize the ground segment development with a model-based approach and it collaborate to overcome challenges associated with cultural inertia and information sharing policies.