

IAF SPACE OPERATIONS SYMPOSIUM (B6)
Ground Operations - Systems and Solutions (1)

Author: Dr. Ana Maria Ambrosio
Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, ana.ambrosio@inpe.br

Dr. Maurício Gonçalves Vieira Ferreira
Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, mauricio.ferreira@inpe.br

Mr. Antonio Cassiano Julio Filho
Instituto Nacional de Pesquisas Espaciais (INPE), Brazil, cassiano.filho@inpe.br

Mr. Ian Grosner
Government of Brazil, Brazil, iangrosner@gmail.com

Mr. Victor Baptista
Universidade de Brasília, Brazil, victor.trbaptista@gmail.com

MODEL-BASED SYSTEM ENGINEERING (MBSE) APPLIED TO GROUND SEGMENT
DEVELOPMENT OF SPACE MISSIONS: NEW CHALLENGES.

Abstract

The space segment includes several mission types, such as: Scientific, Earth Observation, Geostationary, and Educational. New challenges of space missions, a complex system, drive the search for solutions to optimize financial resources, design elaboration with reliability, and reduction development time. Consequently, the ground segment must be aligned with the requirements defined by space segment to improve the synergy between these segments. Traditionally, a ground segment is a ready-to-run system; notwithstanding, during the mission development, new requirements can be requested to the ground segment. In this scenario, it has many questions are raised in order to meet cost, operability requirements and contribute to systemic solutions. Ground segment design has to demonstrate the concepts innovations that are required for the increase in data types and volume, and their processes, communications protocols, as well as modern development methods. These concepts are found in the recommendations of the Consultative Committee for Space Data Systems (CCSDS), as for instance: a) the standardization of the managerial interfaces related to Tracking, Telemetry, and Command (TT&C) services, b) the Space Link Extension (SLE) Protocol services which enabling the cross support and interoperability. In addition, the studies and applications of these concepts collaborate to meet the goals of the Interagency Operations Advisory Group (IOAG), for example, achieving full interoperability among member space agencies (ASI, CNES, CSA, DLR, ESA, ESOC, JAXA, and NASA). The guidelines on systems engineering area cover these concepts for system development as for example those of the European Cooperation for Space Standardization (ECSS) and National Aeronautics and Space Administration (NASA), notwithstanding, not limited to these major entities. This paper provides an overview of space segments and their requirements, which in turn define the ground segment requirements. It also presents a solution based on the Model-Based System Engineering method and the SysML as a modeling language for formally describing and specifying a space system. The paper presents the considerations for the elaboration of an ontology for the ground segment representation, notably for the Satellite Control Center at the National Institute for Space Research. This solution aims to improve and standardize the systems engineering practices and concurrent engineering procedures, establishing methodologies for the development optimization, management and implementation of the ground segment projects with a model-based approach. The paper also describes possible contributions from the ground segment that may collaborate to define and refine the requirements for the space systems architecture and ensuring the fulfillment of

mission objectives.