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LEVERAGING AN INTEGRATED DATA PLATFORM TO SUPPORT SATELLITE CONSTELLATION TRADESPACE ANALYSIS

Abstract

When developing hardware/software systems destined for a space environment, the low margin for error and high complexity of requirements mean data integrity must be guaranteed throughout the development process. This begins as early as ideation and design, in particular when the designer(s) must navigate a large tradespace of candidate systems in order to identify the solution forward. Unfortunately, the software tools involved in space system design typically operate in isolation from one another, making this an inefficient and error-prone process.

The Violet platform addresses this challenge by integrating engineering data from disparate tools into a single shared database, structuring the data as *entities*, and enabling the definition of *relations* between these entities in a common environment. Violet users are then able to query this comprehensive dataset and generate reports containing the relevant information (e.g., project requirements, system architecture, hardware and software design, test campaigns, analyses) in a unified dashboard. The platform also enables continuous execution of scripts and simulations on the latest data as it changes.

Violet can then generate a graph representation of this dataset in the Ontological Modeling Language (OML). By representing the dataset as a knowledge graph, users can leverage semantic web technologies to reason with, query and infer new information from this data. For this effort, the knowledge graph is structured according to the University of Arizona Ontology Stack (UAOS) to ensure its validity. The UAOS is a modular, multi-layered ontology stack founded on the Basic Formal Ontology (BFO). These capabilities are particularly powerful when used to evaluate the consistency, completeness and correctness of a dataset.

In this paper, we show how this approach can be applied to tradespace analysis in satellite constellation design to determine the optimal solution for a given set of requirements and a goal of optimizing for sustainability. We demonstrate how multiple heterogeneous datasets can be integrated in Violet and incorporated in the analysis. We consider legal requirements, such as the Federal Communications Commission (FCC) rule for satellite deorbit, sustainability targets, such as debris and light-pollution mitigation, as well as relevant mission requirements. We leverage a set of cloud-based software tools in conjunction with Python for requirements and analysis, and we model the mission and system architecture in SysML v2.

We show how teams can use Violet and the UAOS to run these analysis pipelines and efficiently verify mission requirements as the tradespace and associated datasets evolve.