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ENABLING EFFICIENT SATELLITE MISSION DESIGN WITH RULE-BASED COLLISION AVOIDANCE

Abstract

The growing number of operational spacecraft in Earth's orbit entails an increasing operational effort for collision avoidance (COLA), particularly regarding the coordination of evasive measures. To reduce the associated workload, COLA operations should already be considered in the early planning phases of space missions.

Mission Analysis Software (MAS) is a web-based application developed within the ESA-funded CASCADE (Collision avoidance, satellite coordination assessment demonstration environment) project by OKAPI:Orbits and TU Darmstadt for this purpose. MAS follows a data-driven approach to offer satellite operators, mission designers, service providers, agencies, and authorities two services: conjunction analysis and rule assessment.

The conjunction analysis provides a representative list of the number of type of conjunctions to be expected on the targeted orbit and identifies frequently interfering parties for the current population of active satellites as well as for conceivable future scenarios. Rule assessment offers a rule-based approach to coordinate COLA between individual operators, allowing users to build custom hierarchical rule sets from pre-defined rule building blocks to achieve a desired split of effort between the conjunction parties. MAS enables the assessment of the operational consequences for a chosen rule set, empowering users to reach bilateral agreements with identified frequently interfering parties to determine the obligation to take evasive measures for future conjunctions. The approach of MAS allows for the pre-emptive reduction of the expected number of conjunctions and the automatization of COLA coordination during operations. Through this, MAS optimizes propellant needs, mission time, and required workforce associated with COLA for space missions.

This paper presents MAS, showcasing the key features and use cases that have been developed closely with stakeholders and the European Space Agency. Furthermore, the data-based simulation approach of MAS will be explained, covering the data sources and design choices for the conjunction detection and

propagation module. The paper also introduces a life cycle model for satellites that is integrated into the MAS simulation. This model takes into account prevalent operations of constellations and single satellites during launch, mission, and disposal phase.

As an intermediate result of an on-going research activity involving the authoring entities, a major goal of the presentation is to engage with satellite operators, mission designers, service providers, agencies, and authorities to tailor the results of the activity to their actual needs.