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MULTI-MISSION PLANNING AND ANALYSIS FOR EARTH OBSERVATION CONSTELLATIONS

Abstract

The next decade will see an unprecedented increase in the volume of Earth Observation satellites launched, as the trend towards operating mega-constellations continues. This increase in the number of spacecraft will result in a corresponding growth in the complexity of payload planning as the resources to be managed and end-users will grow exponentially, making the planning process too complex for a human operator to handle. Existing Mission Planning Systems are unsuitable for the management of multi-missions, as they are limited in terms of scalability and interoperability. In order to maximise the mission return from constellations, new mission planning systems are required, enhanced by advanced automation and Artificial Intelligence techniques. In this paper, we present the EOMPA activity; it is an ESA-funded study which aims to develop a constellation planning system, building on the traditional planning processes and systems while also introducing advanced optimization techniques. The prototype is designed using a Service Oriented Architecture to ease the integration of components of existing tools at ESA. Multiple optimization algorithms are analysed for their suitability to efficiently manage the scheduling of hundreds of requested activities from different users and science teams. The Squeaky Wheel and Ant Colony Optimization techniques are two of the algorithms selected for development. The methods are validated against multiple real-world scenarios, including overlapping requests and last minute re-planning due to a ground station outage.

Additionally, EOMPA was selected as a demonstrator for the new Mission Planning service standards defined by the Consultative Committee for Space Data Systems (CCSDS). This separate activity aims to increase interoperability in the ground segment by standardizing the information exchanged between the parties involved in the planning process. This was achieved by specifying the standardisation of service-based interfaces defining the interaction between providers and consumers. EOMPA adapted the CCSDS defined data-model for information exchange and enabled the services to interoperate based on a formal definition; moving away from traditional file-based formats and resulting in a more streamlined process. Five services were considered for this activity, including the submission of planning requests, their distribution, the management of the planning process, the editing of plans and the plan execution. EOMPA is the first prototype to implement these standards in semi-operational system, improving interactions between distributed systems, supporting federated planning and enhancing interoperability and compatibility within the ground segment overall.