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MAXIMIZING BANDWIDTH DYNAMICALLY IN MULTIBEAM SATELLITES USING A MATHEMATICAL PROGRAMMING-BASED AUTONOMOUS ENGINE

Abstract

Dynamic resource management algorithms have become a priority for satellite operators faced with the unprecedented flexibility and scalability of new satellite systems. Customers have not only increased in quantity and throughput needs, but their demand behavior has also become more difficult to predict. On the system side, modern digital payloads with state-of-the-art beamforming capabilities are now able to sustain hundreds to thousands of active beams simultaneously. As a consequence of all these changes, the role of dynamic resource management algorithms is key for in-orbit operations, especially for allocating shared resources, such as bandwidth among constellations.

When it comes to spectrum management, numerous studies focus on channel allocation algorithms. However, extending the number of controllable variables to include the amount of bandwidth per beam and frequency reuse parameters poses a more complex problem for existing algorithms. The challenge lies in conceiving an algorithm that is capable of robustly making decisions on frequency allocation in near real time, and with the ability to scale up to the size of modern constellations.

To address this gap, in this paper we examine the dynamic frequency management problem from the perspective of autonomous systems and propose an autonomous engine that is capable of continuously reallocating the frequency resources of a constellation in order to adapt to the customer needs. As part of our work, we develop an integer mathematical programming formulation that is based on a linearization of the problem, capturing its complexity and accounting for interference avoidance, power needs, and operation restrictions.

To test the utility of this proposal, we simulate different operational use cases for non-geostationary constellations under scalability and contingency scenarios. The results show that this approach is capable of making optimal decisions in terms of the amount of bandwidth used and power consumed but can also react to uneventful situations, such as the limitation of available spectrum. Finally, aiming to contribute to the generalization of its use, we also discuss how the algorithm could be further exploited to adapt to specific needs of certain constellations that present further limitations.