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POWER FLEXIBILITY OPTIMIZATION OF MULTIBEAM COMMUNICATION SATELLITE PAYLOAD

Abstract

To satisfy the ever-evolving market and application requirements throughout a satellite lifetime, new communication satellites now prefer to consider highly flexible payload architecture. This flexibility is mainly embodied coverage, power and bandwidth of satellite payloads. In a multibeam communication satellite, RF power flexibility is thought to be an efficient solution to handle the traffic unbalance between beams and the variation over the time, which can largely improve the power utilization among beams.

The basic principle of RF power flexibility is power pooling at high-power section. There are two typical high-power section designs, Flexible Traveling-wave Tubes based architecture and Multiport amplifiers(MPAs) based architecture. The power pool of the former architecture is based on DC power sharing, and that of the latter one is RF power sharing.

In this paper, we focus on power flexibility optimization problem of the MPA based architecture for multibeam communication satellites. The discussed payload contains low-power beamforming network, MPA High-power section and multibeam antenna. The optimization target is to improve the power flexibility while maintaining an accepted nominal satellite capacity. The power flexibility principle is analyzed and a power reconfigurable capability estimation method is proposed. And then, we introduce a two-step optimization method.

Firstly, based on the characteristics of MPA in a beamforming system, the beamforming parameters is optimized to improve the estimated minimum possible power reconfigurable capability, while considering the restriction of the beam performance. There are somewhat relationships between the beamforming parameters and power flexibility, that beam directivity performance may be decreased while improving the power flexibility. Thus, optimization result in this step is a tradeoff between the beam performance and RF power flexibility, while guarantee the minimum gain over the coverage and beam to beam isolation.

Secondarily, after beamforming parameter optimization, the route between MPAs and feeds is optimized, to improve the nominal satellite capacity and overall power flexibility. Similarly, according to the characteristics of MPA, the complicated optimization process is simplified into two parts, one is preliminary feed allocation among MPAs, and then feed allocation among ports in each MPA. The restriction in this step is nominal satellite capacity worsen under uniform traffic among beams.

We show an example of the proposed optimization method in a mobile communication satellite design, which contains eight 8x8 MPAs in its high-power section. After optimization, the minimal power flexibility is above 16% and the total loss of nominal satellite capacity is less than 0.5dB.