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LARGE-SCALE LOW EARTH ORBIT SATELLITE CONSTELLATION DESIGN AND PERFORMANCE EVALUATION METHODS

Abstract

Nowadays, more and more large-scale low Earth orbit satellite constellation programs are put forward, such as Starlink, Oneweb, Kuiper constellation. Constellation optimization design is a complex problem, the key is to analyze the relationship between the performance index and geometry configuration. Firstly, the relationships among the large-scale low Earth orbit satellite constellation configuration and constellation coverage performance, service performance, link performance, stability performance are established. A new hybrid model method is put forward, which considers different altitudes, inclinations and orbit planes. The multi-object optimization function is given, which considers the overall cost, the number of orbital planes, the number of satellites per plane, the constellation construction process. Genetic algorithm is adopted to solve the problem. Then, a large-scale low Earth orbit satellite constellation performance evaluation system system is proposed, including the constellation configuration index, mission performance index, operational performance index and engineering management index. The whole period of building, launching, operation and de-orbit are analyzed. The Analytic Hierarchy Process is adopted to evaluate the large-scale low Earth orbit satellite constellation. Finally, three scenarios are carried out, which including the first phase, the second phase and the second phase of Starlink constellation. The constellation performance of different phases are evaluated. This paper focuses on the optimization method and performance evaluation of large-scale low Earth orbit satellite constellation. The analysis indicates that the hybrid constellation design method is effective, and the main factors which influence the large-scale low Earth orbit satellite constellation are summarized. The research can provide references for future large-scale low Earth orbit satellite constellation design.