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AN ENERGY OPTIMIZATION TOPOLOGY CONTROL ALGORITHM FOR SPACECRAFT CLUSTER NETWORK

Abstract

Spacecraft cluster is a kind of distributed satellite system, which consists of several collaborate-working spacecraft. Due to its high survivability and scalability, this cluster system has become one of the key development trends in the next generation spacecraft system construction. In this cluster system, each spacecraft shares the equal status and works with others to accomplish space missions. As a key technology in spacecraft cluster system, space-based self-organized network contributes to connect the distributed spacecraft in an energy-efficient and reliable way, which can improve the survival ability of space system.

Due to the kinematics characteristics of spacecraft, the space-based self-organized network will face more serious and complex network topology issues, such as the frequent spacecraft nodes' entering& leaving and the intersatellite links switch. Furthermore, energy consumption mainly depends on the distance of intersatellite communication, thus the energy efficiency of the network will benefit from a reasonable dynamic network topology control algorithm and path selecting strategy for multi-hop transmission. This study will explore an energy optimization topology control algorithm from three aspects including the energy consumption model of the network, dynamic network topology control and the shortest path scenario of multi-hop transmission.

Greater energy efficiency can be achieved by a sequence of the least energy-cost static topology on account of highly dynamic and cyclical network topology. Firstly, a network topology and energy consumption model will be established according to spacecraft characteristics and Graph theory. Subsequently, an algorithm will be proposed to determine the period and moment of the intersatellite links' switch to divide one network cycle into several time slots based on the least topology variety. Finally, an improved Dijkstra will be applied to analyze the energy consumption of multi-hop transmission for a static topology and figure out the optimal number of the hops leading the shortest path.

This article firstly introduces the concept and basic characteristics of the space-based network topology. Secondly, a model of the energy consumption and topology is established according to the orbit model. The third section provides a method to divide the dynamic topology into several static topologies. Next section illustrates an improving Dijkstra to analyze the optimal number of hops that leads the shortest path for a static topology. The last section performs a simulation to confirm the result that the dynamic topology control algorithm can reduce energy consumption in space network.