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A RELIABLE AND ENERGY EFFICIENT NETWORK TOPOLOGY CONTROL STRATEGY FOR COOPERATIVE WORK IN MULTI-LAYERED SATELLITE CLUSTER NETWORKS

Abstract

With the great improvement of satellite technology in recent years, especially in areas of nano-satellites, low-cost rockets, and launch methods, satellite clusters, as a new space system for future space missions, has attracted a lot of attention. Satellite cluster networks (SCNs) is a novel kind of distributed satellite system in space, consisting of a number of satellites which orbit with others in a certain range and work cooperatively through wireless inter-satellite links (ISLs) to accomplish some specific and complex space missions Because of the relative motion among satellites and the harsh communication environment in space, the ISLs is unstable and it regularly encounters data transmitting errors. So, it is quite necessary to establish a reliable network topology for data transmitting among satellites, especially when in the process of carrying out space missions of cooperative working. Moreover, energy in every satellite is limited and precious and it is fairly essential to decrease the energy consumption of every communication service. But the technique of topology control strategy in SCNs is still immature and there are only a few studies focused on it.

Considering the deficiency of present research, this paper focuses on the problem of the reliable and energy efficient topology control strategy in SCNs with space missions of cooperative work. We first construct the mathematical model of cooperative working for the multi-layered SCNs. Then, the properties of periodicity and prediction of the satellites' relative motion is discussed to generate a proper link cost metric for SCNs. Through the link cost metric of reliability and energy efficiency, this paper proposes two topology control strategies, which optimizes the energy efficiency or the load balancing for SCNs in the premise of the network with the most reliability. Extensive numerical simulations demonstrate that the proposed algorithms have better performance of the average packet loss rate and average energy consumption than before.

This paper is organized as follows: Section 1 generally introduces the background, motivations and contributions of this paper. In Section 2, we define the satellite cluster network model and discuss properties of the link cost metric. Then, we elaborate two kinds of topology control strategies and discuss their properties in Section 3. Finally, we give a numerical simulation example testing the proposed strategies in Section 4, and conclude this paper in Section 5.