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RESEARCH ON TOPOLOGY OPTIMIZATION SCHEME FOR INTER-SATELLITE LINKS OF LASER & KA HYBRID NETWORK IN GNSS

Abstract

As a vital part of the Global Navigation Satellite System (GNSS), the Inter-Satellite Links (ISLs) provide technical support for constellation orbit determination and satellite communication under the limited distribution of monitoring stations. The BDS-3 has established the Ka-band ISLs and will plan to introduce laser ISLs to improve the communication rate and ranging accuracy. Therefore, the key challenge of the hybrid network is how to optimize the topology of the two types of ISLs to achieve better performance, such as the shortest satellite end-to-end communication Time Delay (TD), Position Dilution of Precision (PDOP), robustness, etc. In response to the above challenges, we innovatively propose the following solutions. First of all, in terms of the mathematical model, **the link assignment problem of multiple antennas is firstly summarized as the b-matching problem of graph theory**, and a Dynamic Blossom (D-Blossom) algorithm is proposed to solve it. Unlike the centralized topology of the heuristic algorithm, **the D-Blossom algorithm can distributedly realize the topology optimization and improve the autonomous management capability and survivability of GNSS**. Afterward, considering the complex Acquisition, Tracking, and Pointing (ATP) processes of laser antennas, **we propose three topology planning schemes for hybrid networks, including global dynamic topology, local dynamic topology, and relatively fixed topology.** The above schemes are compared in three aspects of performance: ranging, communication, and survivability. Finally, the proposed method is tested in a simulated case of the BeiDou Navigation Satellite System. The results show that the maximum PDOP of the hybrid network is less than 1.9, and the average TD is less than 200ms. When three satellites work abnormally, the average PDOP and TD damages are less than 15% and 5ms, respectively. **The effectiveness and robustness of the D-Blossom distributed algorithm have been verified.** In addition, the comparative analysis of the three schemes shows that the scheme of the global dynamic topology has the best performance but has higher requirements on the ATP of the laser antenna. **Therefore, the relatively fixed topology is a more suitable choice in the early stage of system construction. With the development of ATP technology, the global dynamic topology can be selected to improve the hybrid network's performance when the laser antenna can quickly establish links.**