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DATA TRAFFIC SIMULATION IN MESH NETWORKS OF SMALL LEO SATELLITES

Abstract

PURPOSE: Mesh networking small LEO (low Earth orbit) satellites increases the usability of a constellation of such satellites by enabling real-time transmission of data collected at each satellite to the ground. This is achieved by transferring data from satellite to satellite using inter-satellite links (ISLs), and after reaching a satellite passing over a ground station, the data is transmitted down to the ground over that satellite's ground link. In addition, mesh networking also adds redundancy to the satellite constellation by providing multiple paths between satellites and the ground station. All this functionality however comes at a price of equipping each satellite with multiple ISLs linking it to its neighbors within the constellation. But adding ISLs leads to an increase in power, size, weight, and complexity of these already resource restricted small satellites. Thus an important design goal for mesh networks of small LEO satellites becomes reducing the number of ISLs, as well as the complexity per ISL (data rate, transmission power etc.) without compromising on the mission data requirements. The inter-relationship between ISLs and mission data requirements isn't so clear though. The reason being that the data generated at each satellite in the constellation isn't always deterministic, and is random event driven in many cases. Examples include tsunami or earthquake monitoring constellations. In order to evaluate the relationship between ISLs and mission data requirements, a software tool is needed to simulate the flow of data traffic under different constellation parameters.

METHODOLOGY: In this paper we discuss the design and application of a simulation tool that we created for the above purpose. Our simulation tool is initially setup using constellation parameters such as the number of satellites and their orbits, the number of ground stations, and the number of ISLs per satellite along with their data rates. In addition, probabilities of data generating events, and the characteristics of the data generated are also input to the simulator. Armed with this information the tool then simulates data generating events as the satellites move through their orbits, and the resulting data flow through the constellation is monitored. Varying the various input parameters shows their effect on the data traffic through the constellation.

RESULTS AND CONCLUSIONS: Simulating different mission scenarios by varying the simulator's input parameters we determine the optimum ISL and ground link requirements for each mission in such a way that data traffic flows smoothly through the constellation without any congestion.