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Riot, V. J. et al. (2021): JoSS, Vol. 10, No. 1, pp. 995–1006
(Peer-reviewed article available at www.jossonline.com)

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Lessons Learned Using Iridium to Communicate with a CubeSat in Low Earth Orbit

Vincent J. Riot, Lance M. Simms, and Darrell Carter

Lawrence Livermore National Laboratory
Livermore, CA, US

Abstract

This paper presents the design and approval process for operating an Iridium transceiver on orbit and provide on-orbit performance data obtained from a CubeSat platform in Low Earth Orbit (LEO) (500 km orbit). On-orbit data demonstrates that use of a commercial, low-cost Iridium transceiver can serve as a valuable communication approach for low volume telemetry with less than a 30-minute lag for approximately 90% of the time. We also demonstrate that a radial differential velocity of 7 km/sec corresponding to about a 37.5kHz doppler shift and a distance of less than 2,000 km can be used for mission planning.

1. Introduction

Setting up a dedicated radio communication link with a CubeSat in Low Earth Orbit (LEO) presents several challenges, especially for institutions with limited funding or resources. The traditional approach of using one or more dedicated radio ground stations to communicate directly with the satellite is often prohibitively expensive for university groups or organizations with limited involvement in space-based applications, and it also requires a significant amount of expertise. The approval and licensing process for radio spectrum allocation with the Federal Communications Commission (FCC) may introduce additional difficulties.

From an operational standpoint, relying on a terrestrial line-of-sight ground station limits the period of time in which the operator can communicate with the satellite. For a satellite in LEO, the typical duration is about 5-15 minutes per day per ground station, depending on the altitude and inclination of the satellite, as well as the latitude of the ground station. This means the operator is oblivious to the current state of the satellite most of the time, even if multiple ground stations distributed across the Earth are used. It also means the operator must plan far ahead in terms of commanding the spacecraft, which can be an issue if the command and data handling unit reboots due to a single-event upset, latch-up, or similar causes.

Several satellite-based communication networks exist to overcome the short communication window problem. NASA set up the Tracking and Data Relay System in the early 1970s, using geosynchronous satellites in an effort to provide near-continuous communications with its LEO satellites. More recently, satel-

Corresponding Author: Lance M. Simms – simms8@llnl.gov
Publication History: Submitted – 04/14/20; Revision Accepted – 01/29/21; Published – 02/26/21