



www.adeepakpublishing.com

Dahir, A. et al. (2021): JoSS, Vol. 10, No. 2, pp. 1049–1060
(Peer-reviewed article available at www.jossonline.com)



www.JoSSonline.com

Forgoing Time and State – The Challenge for CubeSats on Artemis-1

Andrew Dahir, Charles Gillard, Brodie Wallace,
John Sobotzak, and Scott Palo

*Ann & H. J. Smead Department of Aerospace Engineering Sciences
University of Colorado
Boulder, Colorado, US*

Daniel Kubitschek

*Laboratory for Atmospheric and Space Physics (LASP)
University of Colorado
Boulder, Colorado, US*

Abstract

While launch opportunities for small satellites increase with each passing year, there remain gaps in planning for the functional needs of the satellites. For example, small satellites on the Artemis-1 launch will be released from the unpowered Space Launch System (SLS) rocket with no a priori knowledge of their time, position, or velocity (state), and must be able to communicate back with Earth. To accommodate this, there are a variety of different decision pathways that can be taken to ensure that communications can be established with the satellite. One option is to constantly be transmitting time and state from a ground station to the satellite upon deployment, in hopes that the Earth and the satellite will be in a geometry that allows reception of the transmissions. Another option is to coordinate a transmission schedule from that satellite that will have the satellite transmit, wait a period of time to receive any ground communications, then move forward in a specified search pattern until total sky coverage has been obtained. The two final methods are both hardware-based, and include the use of a star tracker located on the CubeSat to find and locate the Earth-Moon system and transmit/receive in that direction, or using a telecommunication system design that provides full-sky coverage. These approaches are important for small satellites, as Deep Space Network assets cannot support the expected growth of deep space CubeSats, thus requiring different approaches. The application and downsides to each of these approaches, along with technical details, will be discussed in this paper, as well as potential downsides with each option.

1. Introduction

The opportunities for small spacecraft launches with the Artemis-1 mission are the first to allow

spacecraft not coupled to a main mission, allowing deep space flight opportunities with deployment opportunities along the path of flight of the Space

Corresponding Author: Alexander Dahir – Andrew.dahir@colorado.edu

Publication History: Submitted – 12/05/19; Revision Accepted – 06/08/21; Published – 07/10/21