IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 3 (2C)

Author: Dr. Evan Anzalone
National Aeronautics and Space Administration (NASA), Marshall Space Flight Center, United States

Dr. Benjamin Ashman
National Aeronautics and Space Administration (NASA), United States

LUNAR NAVIGATION BEACON NETWORK USING GLOBAL NAVIGATION SATELLITE SYSTEM RECEIVERS

Abstract

Recent priorities and investments, both government and commercial, are focusing on a return to the Lunar environment. In addition to an increase in science missions, a host of entities are developing human exploration missions. These investments lead towards a need for expanded architecture and functionality to support expansive and mature operations. In order to support numerous potential missions and maximize return, global coordination systems will be implemented to improve efficiency. To support and coordinate vehicles and explorers, a communication and navigation network will be needed to help guide missions and provide global coverage back to Earth. This paper focuses on the design and architecture of a proposed GNC system that utilizes advances in small-form-factor technology with special enhancements in navigation sensor hardware to provide functionality for small satellite missions in the Lunar Regime. The key technology providing navigation relative to Earth is high altitude-capable Global Positioning System (GPS) or Global Navigation Satellite System (GNSS) receivers.. The proposed system specifically relies on the NASA-developed Navigator GPS receiver, which has set high altitude records, achieving GPS-derived state updates at nearly half the distance to the moon. Recent studies indicate that this technology is capable of supporting strong navigation in the Lunar domain. In the proposed system, GPS will be used to provide a high accuracy navigation and timing reference to other spacecraft. The proposed architecture takes advantage of the GPS-based state solutions to provide navigation capability with other spacecraft through communication-based navigation approaches, allowing for inter-spacecraft (and ground rover) state estimation. The initial use case is to support a large payload lander on approach and descent to the Lunar surface. By embedding this hardware within a small spacecraft platform, this beacon will travel from Earth alongside the lander platform. Through the use of the Navigator receiver, it is possible to provide navigation updates prior to descent. This presentation provides an overview of the capability of the navigation system in comparison to Earth-based radiometric tracking, showing reduced ground support. Additionally, the lander's descent GNC is simulated to show the landing accuracy enabled by the navigation beacon in orbit. These two use cases provide an overview of the potential applications and performance of the proposed network. Lastly, the paper provides a description of potential orbits for the satellite to continue to provide services to future Lunar missions, and their performance in supporting surface operations.