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DEPLOYING A NANOSATELLITE CONSTELLATION FOR LUNAR POSITIONING SYSTEM (LPS): ENHANCING LUNAR SETTLEMENT AND MISSION CAPABILITIES FOR FUTURE LUNAR EXPLORATION

Abstract

Deploying a nanosatellite constellation for a Lunar Positioning System (LPS) is significant for advancing lunar settlement and mission capabilities, aligning with NASA's Artemis mission and future lunar exploration programs. As space agencies plan to establish a sustained presence and settlement on the Moon, reliable navigation, lunar positioning, and communication systems are essential for safe operations and successful surface investigations. An LPS, comprising a network of deployed nanosatellites in lunar orbit, would deliver continuous and precise positioning, timing, and navigation services similar to the Global Positioning System (GPS) on Earth. These proposed nanosatellites are equipped with advanced communication and navigation payloads that coordinate to form an efficient, accurate grid, enhancing the situational awareness of landers, rovers, and astronauts. This system would significantly improve the safety and efficiency of manned and unmanned missions, supporting activities ranging from surface landing operations to extravehicular explorations and transportation. These constellations will offer substantial benefits, including cost-effectiveness, scalability, and adaptability. Their production and launch expenses make it feasible to deploy and expand the constellation according to various mission requirements. Additionally, the nanosatellites' compact design enables various orbital configurations, ensuring robust coverage and redundancy to maintain service even during individual satellite failure. Furthermore, the advanced inter-satellite links and flexible networking capabilities will enhance the reliability of the LPS in harsh environmental conditions. The deployment strategy involves a phased approach, where an initial constellation will be deployed to validate core functionalities such as signal propagation, orbital stability, and surface coverage. The results from this validation phase will help enhance and expand the system into a fully operational network capable of supporting various lunar operations. Finally, through collaboration with international space organizations, deployment timelines, and investment costs can be accelerated. Integrating the LPS with existing moon missions and future lunar infrastructure, such as the Lunar Gateway and surface habitats, would create a unified support system for sustainable activities on the lunar surface. This paper discusses the strategy for satellite production, system configuration, proposed year of launch, algorithms to establish the LPS, and future applications in lunar settlement and deep-space missions