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CISLUNAR POSITION, NAVIGATION, AND TIMING (PNT) – INTERNATIONAL RELATIONS AND POLICY IMPLICATIONS

Abstract

Cislunar space — the region of space gravitationally influenced by the Earth and/or Moon — encompasses a volume roughly 1,700 times greater than the volume of space within geostationary orbit. This includes the lunar surface, lunar orbits, Earth/Moon transfer orbits, and highly elliptical Earth orbits. As spaceflight for military, civil, and commercial purposes becomes increasingly common, it is expected that there will be a dramatic increase in missions to cislunar space over the next decade. Perhaps most notable of these is NASA's proposed Artemis series of missions, which includes plans for a Lunar Gateway space station in lunar orbit as well as a permanent research station on the lunar surface.

Position, navigation, and timing (PNT) refers to a spacecraft's ability to accurately determine its location and orientation; apply corrections to its course, orientation, and speed to maintain its desired trajectory; and acquire and maintain precise time. On Earth, PNT is commonly achieved via Global Navigation Satellite Systems (GNSS) such as the United States' GPS system or the Russian GLONASS system. At present, there is no standardized or ubiquitous PNT system for spacecraft operating in cislunar space, and the United States and other nations have expressed interest in developing this technology to facilitate future space missions. Possible architectures for a cislunar PNT system include satellite networks in lunar orbit, an extension of the usable range of existing GNSS systems, navigation satellites placed in highly elliptical or transfer orbits, Earth- or Moon-based surface beacons, or any combination of the above.

Technical efforts to develop these systems are ongoing. However, the international political landscape that underpins these activities remains fragmented. Here, we examine the key stakeholders in the creation of a cislunar PNT system. We also identify and analyze the critical international debates and policy issues that will be relevant in the development of this technology, such as military vs. civil involvement, signal quality and access, international cooperation, and interoperability. We draw on current debates as well as international developments that occurred in the context of developing terrestrial GNSS systems. We offer insights that can help guide the development of policy in this area.