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IN-SITU NAVIGATION AND TIMING SERVICES FOR THE HUMAN MARS LANDING SITE

Abstract

In [1] and [2], we introduce a new geometric trilateration method that simultaneously performs absolute positioning and relative positioning. The relative position is derived from a "differencing" function of two raw-range measurements between a known reference point and of the target from a navigation satellite, thereby eliminating most of the common errors like atmospheric delays, ephemeris errors, and instrument delays in real-time. In the Mars environment this "self-calibrating" function greatly reduces the need to perform extensive orbit determination (OD) of the navigation satellites like the Earth's GPS, and only requires occasional tracks from the Deep Space Network to perform OD's. Leveraging on this scheme, we propose a low-cost low-maintenance regional navigation satellite system architecture that provides in-situ navigation and timing services for the robotics and human missions in the vicinity of the Mars landing site.

This architecture is built upon the proposed Mars relay network infrastructure, and a number of notional Mars orbiting and surface missions in the human Mars era. We assume two areostationary Mars relay orbiters that have continuous line-of-sight visibility with the Mars landing site, a Deep Space Habitat (DSH) in an elliptical orbit with the apoapsis hovering over the Mars landing site, and a surface communication tower that can serve as the reference site. These orbiting and surface infrastructure elements broadcast GPS-like ranging signals and other ephemeris information to the mission users. With one or more additional orbiters in areosynchronous orbits that trace around a figure-8 path, a regional navigation satellite system can be realized that provides in-situ coarse absolute localization and precision relative localization and timing services to the users in the vicinity of the Mars landing site.

References:

[1] K.Cheung, C. Lee, "A Trilateration Scheme for Relative Positioning," IEEE Aerospace Conference 2017, Big Sky, Montana, March 2017. [2] K. Cheung, C. Lee," A Trilateration Scheme for GPS-Style Localization," Interplanetary Network Progress Report, to appear in May 2017.