

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Interactive Presentations - IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (IPB)

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MOONLIGHT INITIATIVE: E2E NAVIGATION MISSION DESIGN OVERVIEW

Abstract

As global enthusiasm for lunar exploration surges, there is an increasing demand for innovative systems capable of supporting the challenging requirements of exploration endeavours. Telespazio has led a consortium composed by major European Aerospace industries to study with ESA the feasibility of lunar communication and navigation services around the Moon. This paper investigates the capabilities which a Lunar Navigation Satellite System could open for institutional and private assets which aim to navigate the cislunar environment and reports the solution for the architecture design of this system, its capabilities in terms of provided services and the major results in terms of navigation performances which are granted to the final users. The Earth ground segment is in charge of system control and monitoring, navigation message uploading, timekeeping and clock corrections. In order to perform simultaneous tracking and control of the entire constellation, both reducing the ground segment requirements and improving the E2E Navigation performances, the innovative Multi Satellite Per Aperture (MSPA) technique from one single small diameter (lower than 1m at X band) ground antenna is used. The Space segment is made up of satellites for navigation purposes positioned in Elliptical Lunar Frozen Orbits so to minimise the necessity for station keeping manoeuvres, while granting both a high temporal coverage and a low “Height constrained Horizontal Dilution Of Precision” (HHDOP) to the users in the Lunar South Pole region, which is the area subject of major interest. The deployment of the constellation is imagined with an incremental approach, starting with one satellite and scaling up to the full constellation. The service provision will follow the same approach, starting from initial capabilities services (e.g., One way ranging, Two-way measurements, service monitoring and performance prediction) and arriving at full operational capabilities (e.g., PVT service, Time dissemination service and all of the above mentioned). The outcomes are particularly relevant to the growing interest in lunar exploration and represents the first attempt of transposing the GNSS concept outside the Earth environment, facilitating the access to the Moon and proving as a cornerstone for future developments of similar systems in the Solar system.