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PRELIMINARY DESIGN OF A LUNAR GNSS CONSTELLATION

Abstract

A new lunar race is underway. In the past few years, international space agencies have shown strong interest in going back to the Moon, as it is to become a hub for future missions on Mars and beyond. Indeed, NASA's Artemis program plans to return humans to the Moon by 2024, and ESA foresees a permanent international lunar station within the next two decades. In this context, a navigation system will be necessary to extend the effectiveness of the lunar surface exploration. It will offer efficient positioning to humans and real-time rover driving. Moreover, all moon missions require accurate knowledge of the spacecraft's position and velocity. Currently, this is done by ground control teams using ranging as SLR. A navigation service will enable autonomous spacecraft navigation on lunar orbit and reduce tracking. It will also provide redundancy for critical phases as lunar landing and ascent, as well as precise timing services for numerous applications. The proposal focuses on a GNSS constellation able to deliver localization and time services on the Moon and for spacecraft flying on the LLO, for at least 10 years. Also, the system has been designed to provide a Short Message Service alert in case of an urgent situation that would require assistance. The team consists of 7 students working weekly on the project since November 2020. Each member has one management role to share duties. Moreover, for each subsystem (TT&C, structure, avionics, propulsion, power, thermal control, and payload), one accountable and several responsible have been assigned to work efficiently. Current researches underline that one of the best locations for a first lunar outpost could be on the poles (presence of water, power supply advantages). For this study, a lunar base is supposed to be placed close to the Shackleton crater on the South pole. Thus, the services should have higher performance in this area. Firstly, the orbit choice is discussed regarding factors such as the orbit stability, system cost, and global/poles GNSS performance: GDOP, availability, and position error at 3σ. On a second note, the paper will extend on the platform and payload subsystems. The later shall meet its requirements regarding the precision of its accuracy service without using GNSS Augmentation. In this work, the ground control segment is on Earth. Finally, the paper will cover the final system costs

predictions and its possible enhancements, as using a lunar ground station.