22 - Navigating The Moon

Navigating the Moon introduces a general navigation system to the Moon. The need for Lunar navigation has been on the rise, due to the current growing interest in Lunar missions from both private and government organisations. Approximately 250 have already been planned, with their target: the Moon. This includes rovers, humans, landers and orbiters. Developing such missions is complex, as various systems require extensive engineering efforts. An accessible navigation system will reduce the complexity and cost, thereby encouraging the development of future Lunar missions.

Mission Objective

All Lunar missions could benefit from operational independence from Earth, thus the mission objective is: “Produce a conceptual design for a navigation system on the Moon that is capable of providing service to Lunar missions, starting deployment by 2028". To achieve this goal, a team of 10 students will explore the possibilities of Lunar navigation for a 10-week period.

System Design

Navigating the Moon shall provide navigation services to users with an accuracy of 10 m on the Lunar surface. Additionally, the concept shall have a minimum four-fold coverage for an altitude up to 200 km. This poses a constraint to the mission and consequently influences the design of the concept.

Several concepts for this mission were investigated, leading to the final concept of a Lunar constellation. The concept of a Lunar constellation complies with all mission requirements.

Contrary to conventional missions, the control segment is part of the spacecraft architecture. It is performed using inter-satellite communication and on-board algorithms. For monitoring purposes only, ephemeris data is relayed to Earth, adapting Lunar Pathfinder as a communication link.

The final mission design is a constellation consisting of 35 satellites, situated in 6 frozen orbital planes. Each satellite has a mass of 808 kg (dry) and 1047 kg (wet), requires a power of 1700 W at a cost of €50 million per satellite. The satellite is designed for a mission lifetime of 12 years, providing accurate navigation services for over 95 % of that period.

In line with the current trend to strive to increase sustainability, the spacecraft is designed to use the green propellant: AF-M315E. Furthermore, solar arrays are selected over Radioisotope Thermoelectric Generators because of their harmful radiation. Moreover, due to the prospect of future human presence on the Moon, End of Life procedures have imposed an intricate part in design. As the final step of the mission, the satellite will de-orbit, and impact in a designated crater. These aspects lead to a design with a reduced environmental impact on both the Earth and the Moon.

In the following week, more emphasis will be put on the assembly and deployment of the mission, covering: complexity, cost and time. Additionally, the CAD model will be improved to provide more accurate values for a final iteration. The current version of the CAD model can be seen in the figure below.