Mission analysis

Mission analysis report

Mission analysis is a crucial aspect of space mission planning, involving a comprehensive review of satellite orbits and trajectory options to ensure the mission objectives are successfully met. This report presents the detailed mission analysis conducted for the project, which includes an evaluation of potential trajectory options, launch windows, and operational risks. The analysis spans the entire mission lifecycle, from initial concept to final operations, ensuring that all mission parameters are optimized for achieving the desired outcomes.

In this report, we will outline the findings of our mission analysis, including both baseline and alternative solutions, as well as the reasoning behind the selected trajectory. The comprehensive assessment provided here is designed to assist the project team in making informed decisions that align with the mission's goals while ensuring safety, efficiency, and success in space operations.

1. Mission requirements and constraints

Objectives

The mission's objective is to collect data on Radio Frequency Interference (RFI) at L-Band and K-Band across the entire globe using PocketQubes, one dedicated to each frequency band, while also also disposing of another PQ capturing images of Earth with a VGA camera. Ideally, we aim to study a significant portion of the Earth's surface to gain a comprehensive understanding of global interference patterns. This requires certain orbital inclinations to be more suitable for observing higher latitudes. However, the mission has been designed with flexibility in mind, enabling the satellites to be launched under a variety of conditions.

Considerations

However, considering the type of satellites we will be using and the guidelines set by ESA's FYS4!, there are still several factors to address. These include ESA's Space Debris policy, explained in the Space Debris Mitigation report and the constraints outlined in the Link Budget.

Orbit compatibility

The following section details the results of our mission analysis, focusing on achieving maximum adaptability while adhering to the Space Debris policy and link budget constraints.

Altitude Range

For this part of the mission we need to consider the following factors:

ESA Zero Debris Approach

According to ESA Zero Debris Approach, the duration of orbital decay must be less than 5 years. As stated in the Space Debris Mitigation report, this requirement can only be met at specific altitudes and launch dates. The SDM report suggests that the optimal altitude should be between 450 km and 550 km.

Link Budget limitations

As outlined in the Link Budget provided for the Satellite Project File, the altitude impacts the free space losses encountered during the mission. Analyzing the three scenarios studied, communication is feasible in both the favorable and nominal scenarios (500km altitude). However, communication becomes more challenging in the adverse scenario. Taking into consideration these limitations we conclude that the optimal altitude range for our mission is from 450 km to 550 km.

Orbit Inclination

Two factors need to be taken into account selecting the orbit inclination:

Earth observation

The primary factor to consider is the mission's purpose. As stated at the beginning of this report, our objective is to collect data on Radio Frequency Interference (RFI) at L-Band and K-Band and images (VGA) globally, which requires the satellites to regularly pass over most regions of the world. Based on fundamental orbital mechanics, this can only be accomplished at higher inclinations (80 to 100 degrees).

Minimum number of passes over GS

A minimum number of passes over the ground station (GS) must be taken into account. For example, as outlined in the Link Budget Analysis, with typical Earth observation inclinations (80 to 100 degrees), there is at least two to three communication pass per day.

In conclusion, the optimal orbit inclination for our mission should be between 80 and 100 degrees, ideally as close to a Polar orbit as possible to ensure global coverage. However, adaptability is a crucial aspect of our mission. Therefore, lower inclinations, such as the ISS inclination of 51.6 degrees, can also be considered. This inclination still covers a significant portion of the Earth, allows for five passes per day, and provides the opportunity to deploy the PocketQubes from the ISS.

Additional aspects

Eccentricity: Near zero, circular orbit.
SSO: Not required.
RAAN/LTAN: No preferences.