Paper ID: 86584
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31st IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Satellite Operations (3)

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MISSION OPERATIONS FOR PRECISE IN-ORBIT COLLISION PREDICTION AND SPACE ENVIRONMENT SURVEILLANCE

Abstract

The growing number of satellites in low Earth orbit (LEO) poses an increasing risk to critical infrastructure in this region of space. Besides unintended close encounters or collisions between spacecraft and due to the changing geopolitical situation an increase in the number of intentional close encounters is expected. While the objects in LEO are already monitored closely from ground, it is difficult using ground-based infrastructure to monitor every object with a high resolution and provide a collision prediction, for approaching object with propulsion systems. Therefore Jena-Optronik (JOP), a leading company for optical space sensors, addresses this by enhancing their sensors for space situational awareness (SSA) applications. In a student project carried out at Technische Universität Berlin (TUB) the Precise In-Orbit Collision Prediction and Space Environment Surveillance System (PRINCESS) mission concept was jointly developed to demonstrate SSA capabilities using JOP sensors.

The main mission objective is to provide in-orbit generated sensor data to JOP for validation and qualification. A student team at TUB designed the mission, the three satellites – based on spacecraft from TUB's QUEEN and NanoFF missions – as well as the operation plan, and JOP provided support and the customer's viewpoint. Following the lecture the mission is picked up by scientific staff at TUB for further refinement. Here we present a more detailed description of the required space and ground segment elements together with the operational aspects of PRINCESS. A Mothership carries the SSA sensors and the broadband communication equipment, while the two Freeflyers, equipped with a propulsion system, perform proximity relative maneuvers. An inter-satellite link is used to communicate data between the space segment elements.

The two major challenges identified by us for PRINCESS are firstly the downlink of the payload data, which is composed of raw image data from two star trackers and two thermal infrared cameras together

with data of a single LiDAR on the mothership. The payload data is further composed of attitude and orbit state vector estimates. We have analyzed required downlink capacity based on an optical terminal and an X-band transmitter on the Mothership with multiple optical and X-band ground stations, among them the TUB X-band station in Berlin, Germany, and the TUB Optical Ground Station (TUBOGS) in Neustrelitz, Germany. Secondly, the formation keeping with two dissimilar kinds of spacecraft in terms of the ballistic coefficient was identified as a challenge.