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END-TO-END MEASUREMENT ENVIRONMENT FOR AN ELECTRICAL STEERABLE KA-BAND INTER-SATELLITE LINK ANTENNA

Abstract

The Institute of Astronautics {LRT Lehrstuhl Raumfahrttechnik} at Technische Universitaet Muenchen has a strong background in inter-satellite communication. The efforts were driven by the need of developing key methods and hardware for controlling robotic space applications by a user on ground. In this framework, research was conducted to control robotic applications on Earth via a geostationary relay satellite. As a first step of the research activities, LRT focused on one of the common used frequency bands, S-band {2 GHz}. Therefore, LRT was developing an inter-satellite link antenna for communicating with the European Advance Relay Technology Mission {ARTEMIS}.

However, extensive tests and studies showed that a higher bandwidth is necessary to fulfill the high performance requirements on a communication link for robotic systems with haptic and visual feedback on On-Orbit missions. Thus, a Ka-band inter-satellite link antenna and a Ka-Band satellite mock-up system was set up at LRT. The Ka-Band inter-satellite link antenna was developed together with a two degrees of freedom steering mechanism. With this development the Institute of Astronautics got one step closer to the realization of a continuous available inter-satellite communication link between the On-Orbit Servicing {OOS} spacecraft in low Earth orbit and the relay satellite in geostationary orbit. The maneuvering strategy for an OOS rendezvous and docking scenario requires also an inter-satellite communication for the last docking distance between the servicer and the target satellite. During this phase it is necessary to minimize attitude disturbances on the servicing satellite, which implies that a mechanical steering of the inter-satellite antenna is not recommended. That fact led to the need of an electrical beam steering antenna. Funded by the German Aerospace Center {DLR}, LRT developed an electrical beam steering antenna for inter-satellite communication in Ka-Band. A major goal of this research project is the realization of a representative End-to-End test for verification of the functionality under realistic conditions, e.g., using a real relay satellite like ARTEMIS.

This paper describes the concept for an End-to-End test environment using the developed Ka-Band inter-satellite antenna in combination with the Ka-band mock-up system of the LRT. As the Ka-Band mock-up is an outdoor 3-axis attitude simulator facility, the paper further outlines the major aspects, which had to be taken into account with respect to the communication link calculation {atmospheric influence, spot pattern reconstruction, gain variations etc.} and attitude control of the servicer satellite and the relay satellite, like attitude biasing.