IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Interactive Presentations - IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (IP)

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LUCAS: JAXA'S NEW OPTICAL DATA RELAY SYSTEM-THE RESULT OF ON-ORBIT TECHNOLOGY DEMONSTRATION AND ACHIEVED PERFORMANCE

Abstract

In September 2024, JAXA successfully completed an in-orbit technology demonstration of the optical data relay system "LUCAS." The user data rate of 1.8Gbps is the world's fastest for GEO-LEO optical communications in the 1.5m band. This paper introduces an overview of LUCAS, the status of in-orbit technology demonstration, and our future plans. LUCAS is JAXA's new data relay satellite in geostationary orbit (GEO), which adopts optical inter-satellite link between the GEO satellite and user spacecrafts in low earth orbit (LEO). JAXA's previous GEO data relay satellite,"Kodama", provided a data-relay communication service up to 240 Mbps, which is based on Ka-band RF inter-satellite link. By using optical communication technology, LUCAS can increase the mission data transmission rate to 1.8Gbps, while the antenna diameter can be reduced to 1/25. This allows LUCAS to achieve both a small and lightweight terminal and large-capacity data transmission, which are required by Earth observation satellites. In addition, while being equipped with such cutting-edge technology, it also has sufficient reliability and design life as an operational communication infrastructure system. The data relay satellite was launched in November 2020, and operational readiness was confirmed through a checkout campaign including direct optical link tests with the National Institute of Information and Communications Technology (NICT) Okinawa Optical Ground Station. Meanwhile, ALOS-4 was put into orbit in July 2024, and its checkout campaign was carried out sequentially. After that, the first acquisition and tracking trial of inter-satellite optical link between the two satellites was succeed on September 14, 2024, and the first communication was established two weeks later. Since then, as of the end of February 2025, about 100 links have been successfully performed, and further, downlink of ALOS-4 SAR observation data have been successfully performed. LUCAS is operated in a technology demonstration phase until one year after the launch of ALOS-4 (the end of June 2025). During this phase , in preparation for full-scale service provision for ALOS-4 starting in July 2025, we will continue to validate the LUCAS overall system and make improvements, such as adjusting various parameters, to improve communication quality and the success rate of link establishment. We are also working to developing new users. We will introduce some plans such as to install a terminal on the ISS "Kibo" and transmit its data, satellite communication experiments between an aircraft and GEO, and experiments between optical ground stations and GEO to understand Atmospheric propagation characteristics.