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IN-ORBIT DEMONSTRATION OF NEAR REAL-TIME COMMUNICATION UTILIZING THE GLOBALSTAR FOR TIME-DOMAIN ASTRONOMY

Abstract

Demonstration of an RF transmitter for sending short messages from the low-earth orbit to the ground via Globalstar is presented. Currently, astronomers are interested in "time-domain astronomy," which focuses on transient phenomena related to explosions in the universe, such as gravitational wave events. In this research field, earlier observations are crucial for understanding what occurred at the central engine. For this purpose, we are developing an exploration mission in UV sky. In addition, astronomers plan to promptly commence multi-wavelength follow-up observations in collaboration with ground-based telescopes. Generally, the raw image data taken by the telescope is transmitted during communication passes with the ground station. However, due to the limited communication frequency, typically a few times a day, this can result in communication delays of up to nearly half a day in the worst-case scenario. To initiate follow-up observations promptly, a real-time communication network is necessary to transmit a detection alert containing information about the source, including coordinates and magnitude.

We have focused on a real-time communication system utilizing commercial satellite constellations and started to develop this system. This system enables any satellite to realize real-time communication by mounting only one Globalstar transmitter. We have demonstrated the real-time communication function with the Globalstar transmitter aboard Tokyo Tech's micro-satellite HIBARI launched by JAXA's Epsilon rocket in 2021. During the two years of in-orbit operation of HIBARI, we obtained necessary information for the construction of the real-time communication system, such as communication delay time, communication success probability, and communication coverage, when this transmitter was integrated into the satellite system.

In these days, we are developing a micro-satellite "PETREL" which has the UV astronomy and Land/Sea observation mission and is scheduled to launch in the future. We aim to demonstrate the real-time communication system by mounting the Globalstar transmitter on PETREL. PETREL has a requirement to send a detection alert including necessary data to start follow-up observations of transient phenomena within 30 minutes. Therefore, we considered the data for the follow-up observations, such as coordinates and magnitude including its required accuracy, and created a data format for PETREL's alerts. Furthermore, based on the demonstration results of HIBARI, we designed the transmission method such as transmission frequency, and transmission interval time, and confirmed that the mission requirements could be achieved.