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Author: Dr. Tetsuo Yoshimitsu
Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency, Japan

Prof.Dr. Takashi Kubota
JAXA, Japan
Dr. Atsushi Tomiki
Japan Aerospace Exploration Agency (JAXA), Japan

COMMUNICATION SYSTEM OF MULTIPLE DEPLOYABLE PAYLOADS WITH RANGE MEASUREMENT CAPABILITY

Abstract

Hayabusa2 asteroid explorer got some fragments from the asteroid Ryugu and brought them back to the Earth in 2020. It included total of four payloads which were deployed onto the asteroid surface. The payloads were developed by several organizations but used a common module to communicate with the mother spacecraft which stayed at the vicinity of the asteroid.

The telemetry data generated in payloads were once stored in the relay component of the mother spacecraft, and then transmitted to the Earth. The commands sent from the Ground station were also stored in the relay component and then transmitted to the payloads when the downlink radio from the payloads was sensed at the relay component.

Maximum of four different payloads can simultaneously communicate with the relay component using two different frequencies of downlink radio from the payloads to the mother spacecraft and Time Division Multiple Access (TDMA) technique.

The communication system also had a range measurement capability between the relay component and the payloads.

The distance is measured by the time of flight of PN codes inserted during the guard time after the relay component has stopped the uplink radio transmission to the payloads. When a payload receives PN codes, it relays the same codes during the guard time after it has stopped the downlink transmission to the relay component. The relay component measures the time of flight of PN codes to get the round trip distance.

There is no clock synchronization between the relay component and the payloads. The internal delay at payload from the reception of the codes to the transmission of the relayed codes is calculated using the clock count of the payloads sent to the relay component independently included in the control information of TDMA system.

There were three deployment operations conducted after Hayabusa2 had arrived at the asteroid. They were made in September 2018, October 2018, and October 2019. The data transmission and the range measurement were successfully made for all the three deployment operations.

The performance of the communication system was evaluated on the ground using a small balloon prior to the first deployment operation.

This paper describes the communication system used for the payloads deployed onto an asteroid surface, the range measurement capability as well as the results of the Ground-based experiment and the actual operations.