Methods for Development and Operation of Microsatellite Bus System and Ground Station in PHL-MICROSAT Project

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Since Tohoku University and Hokkaido University started the operation of microsatellite SPRITE-SAT(RISING) in 2009, 50-kg microsatellites dedicated for scientific earth observations are being developed and operated continuously. Inheriting the satellite bus system in RISING-2 which operation started in 2014 and RISESAT which is being developed, first Philippines' microsatellite DIWATA-1 could be completed and its operation started on April in 2016. This satellite is first satellite in the PHL-MICROSAT Project which is joint microsatellite development and operations by Philippines and Japan. In this presentation, development and operation experiences in satellite bus system for DIWATA-1 are described. This achievement can contribute to other new partners in Asian Micro-satellite Consortium (AMC) and technical requirements and performance about satellite and ground station development will be defined.

DIWATA-1 has 52.4-kg mass and the size is 55x35x55 cm. This was released into orbit by International Space Station (ISS) at 403-km height with 51.6-deg inclination. After about 2.5-year orbital lifetime, its mission will finish by re-entering to atmosphere. By using High Precision Telescope (HPT) with 3-m resolution and Spaceborne Multispectral Imager (SMI) with 61-m resolution, the satellite can observe the natural resources on ground, forest, and ocean in Philippines. The wavelength of SMI can be set with 1-nm step in the range of 430-1020 nm. By the attitude control function with target pointing mode, multi spectral images of same target place can be obtained in same observation opportunity.

Satellite bus system for DIWATA-1 was developed by six Filipino students under the supports by faculty members in Tohoku University. Preliminary design started on Nov. 2014, and the satellite could be delivered to launch organization in Jan. 2016, which total duration was only 14 months. To avoid the troubles in design, fabrication and environmental tests, deployment mechanism such as solar paddles was not adopted. Typical consuming power is 49.7 W in image capture mode and 56.9 W in data download mode although body-mount cells generate 38.6 Watts in average. To achieve the stable power management, the attitude control system is active only in Philippines and Japan, and it can safely return to power saving mode in other areas. Of course, the satellite has the ability to capture images also in other world areas. Next satellite DIWATA-2 will include a low-cost and high reliable solar deployable paddles and the observation ability will be upgraded more.

Satellite operation technology accumulated in Tohoku University was inherited to new satellite ground station which was constructed at Advanced Science And Technology Institute (DOST-ASTI) in Philippines. The satellite tracking antenna system is different from Tohoku University and its compatibility is not important. The automatic action of tracking antenna can be individual managed in Philippines and Japan. However, same transmitter, receiver, and satellite operation software were exported from Japan to Philippines to achieve the high-level compatibility in satellite operation methods. After the finish of initial operation from Japan, the methods to upload satellite operation commands and download observation images were transferred to Philippines' local operation team, then the satellite can be fully operated in Philippines now. In this PHL-MICROSAT project, quick construction of satellite operation system could be achieved as well as quick development of microsatellite. These experiences can contribute to next activities with new partnership in AMC.

Keywords: microsatellite, satellite bus system, satellite operation, DIWATA-1, Asian Micro-satellite Consortium