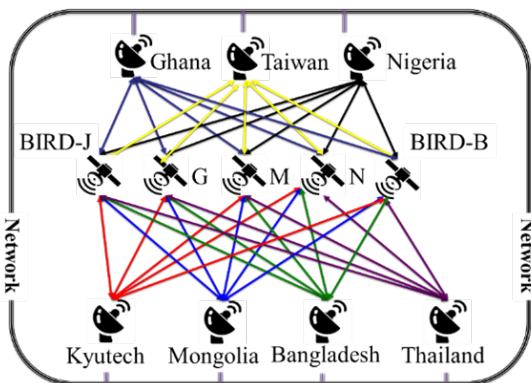


Design and Development of Ground Station Network for CubeSats Constellation, Joint Global Multi-Nation Birds

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Introduction

The Joint Global Multi-Nation Birds (JGMNB) project [1] shortly “BIRDS” is a multinational project for capacity building towards sustainable space program in participating countries. BIRDS project is a satellite constellation project where 15 students from Japan, Ghana, Mongolia, Nigeria, Bangladesh and Thailand currently enrolled in Space Engineering International Program, Kyushu Institute of Technology. This constellation of five IU CubeSats is planned to be released to the orbit from International Space Station in fiscal year 2017. BIRDS CubeSats carry two cameras on-board as a main payload and the main mission is to capture photographs of the homeland of participating countries, and send image data back to the Earth via the communication systems using UHF/VHF amateur radio frequency. BIRDS project ground station network (BIRDS GSN) is designed to support the communication systems of five BIRDS CubeSats by connecting the seven ground stations of each member countries by internet network to increase the communication time between ground station and satellite. This work can increase the downlink data throughput and then ground station can download more data from CubeSat. During the operation time, each ground station shall access the operation plan through the pre-programmed in the central server, and uplink a set of command to CubeSats, as well as receive mission data from CubeSats by using the satellites tracking system. Afterwards, the received mission data will be stored in the central database.



BIRDS GSN Concept



BIRDS GSN Member

BIRDS Ground Station Network

The current member of the BIRDS ground station network project includes Kyushu institute of Technology in Japan, National University of Mongolia in Mongolia, All Nations University College in Ghana, The Federal University of Technology Akure in Nigeria, BRAC University in Bangladesh, King Mongkut's University of Technology North Bangkok in Thailand and National Cheng Kung University in Taiwan.

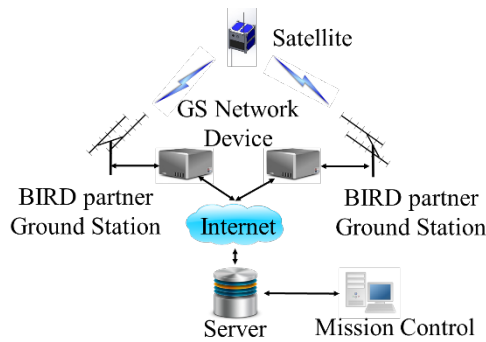
Currently, the ground station already has been installed in Japan, Ghana and Taiwan and other member are in process of development the ground station in their country.

System Architecture and Design

The BIRDS ground station network architecture includes three main parts such as Ground Station Network Device (GSN Device), Central Server and Mission Control Center.

- Ground Station Network Device will be installed at each BIRDS ground station. The GSN device is comprised of a data transfer module and a Software Define Radio (SDR). This equipment is used to transfer the mission data and I/Q data from SDR to be collected in the central server. Moreover, it shall access to the central server for a satellite operation schedule that used to control each ground station.

- The central server has a database to accumulate the mission data that has been received from satellite and collect the satellite operation schedule to send to command each ground station. The central server will be located at Kyushu institute of Technology, Japan.
- Mission Control Center is used to program the satellites operation schedule following the project mission and send to collect in the central server.



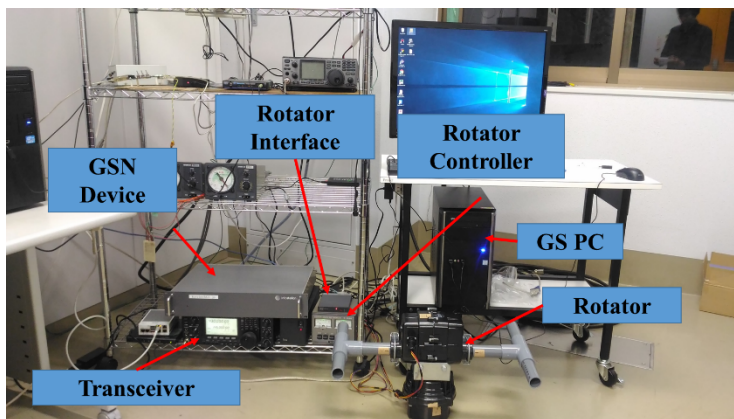
BIRDS GSN Architecture



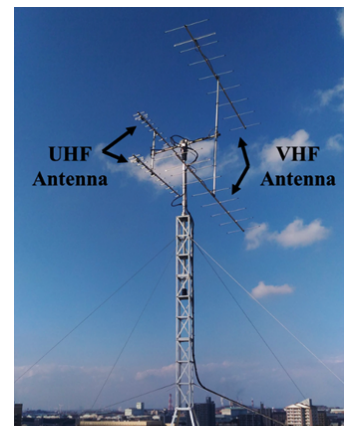
BIRDS GSN Device

Test Result

The functional and integration tests were performed to verify the functionality, compatibility of the ground station system with BIRDS satellites. In the functional test, CW beacon and mission data were received and decoded at ground station, and uplink command was successfully transmitted to the satellite. And in the integration test, the received data at ground station was successfully at GSN Device and transferred and stored in the central server.



GSN Integration Test



BIRDS GS Antenna

Conclusion

BIRDS project ground station network is proposed and designed to support the BIRDS project missions by connecting the seven ground stations of each BIRDS project member countries by internet in order to increase the communication time between the ground station and satellite. BIRDS ground station network is able to improve the downlink data throughput.

Reference

[1] Arifur R. Khan, George Maeda, Hirokazu Masui, JGMNB project member and Mengu Cho; Five Nations CubeSat Constellation; An inexpensive test case for learning and capacity building. 3rd IAA Conference on University Satellite Missions and CubeSat Workshop & International Workshop on Lean Satellite Standardization Rome, Italy. Nov, 2015