UNIVERSITI TEKNOLOGI MARA

THE SYNCHRONISATION OF GROUND SENSOR TERMINAL (GST) ARRAY FOR STORE-AND-FORWARD (S&F) OF NANOSATELLITE MISSION

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ABSTRACT

Digital transformation is changing how the world adapts to the development of technologies to improve daily life. Satellite technology changes how the information or data management in the vast network. Malaysia, specifically UiTM is proud to be part of BIRDS members with the development of the UiTMSAT-1 nanosatellite. This UiTM's first nanosatellite brought onboard six (6) missions which include a demonstration of Store-and-Forward (S&F) technology for remote data collection. This study relates to the S&F technology where it centres on the ground system. This study explores the synchronisation method for an array of Ground Sensor Terminal (GST) units to communicate with a single nanosatellite with the S&F technology. The design of the GST system was based on BIRDS-2 UiTMSAT-1 specific design. The function of GST is to transmit packet of Earth-based sensor data to nanosatellite; hence the ground-space link communication and interoperability components of the GST system were investigated. The proposed GST system prepared the sensor data into the format of AX.25 and transmitted the formatted packet to nanosatellite using an amateur radio band at a very high frequency (VHF). Commercial off-the-shelf components were used in assembling the GST system, categorized as the sensor unit, the control unit, the transceiver, and the VHF omnidirectional antenna. The estimated link budget calculates the attenuation parameters such as free space path loss, antenna mismatch and polarisation losses, and several other aspects to ensure the communication link between ground to space can be established properly. The uplink and downlink budgets estimation were calculated, and it was observed to provide a positive margin at 25.5 dB and 11.2 dB respectively for overhead satellite pass. Following the study objectives, the data transfer synchronisation method for the array of GST was selected; inspired by the Self-Organized Time Division Multiple Access (SOTDMA) scheme. The research focused on the situation when all three (3) ground sensor terminal units are within the same nanosatellite's footprint. The ground to space communication time window was divided between three GST units. The time allocation of the communication window for synchronising three ground sensor terminal units was portrayed by running the simulation programming code. Several tests on the GST system were performed with a spectrum analyser or satellite prototype (the receiver) to observe the transmission at short distances at various places. The data synchronisation codes were simulated using Raspberry Pi as the controller. X becomes the variable in the codes where it represented the simulated duration of communication time. In the real application, X will be the value of distributed communication window of GST and nanosatellite. The three codes (representing three GST units) were executed on one Raspberry Pi to verify the transmission sequence. The simulated testing shows no collision between terminals as recorded in the Activity Log CSV file. Additionally, three Light Emitting Diode (LED) components were connected to the Pi's General-Purpose Input/Output (GPIO) pins, to simulate three GST units. The research findings will help to introduce a potential technique for data transfer synchronisation between ground terminals for store-and-forward applications. In addition, the introduction of multiple GST units in transporting ground-based sensors' data using satellite is beneficial especially in rural and limited internet access areas where more data can be gathered at one time.

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