

ABSTRACT

The University of North Dakota (UND) is planning to operate its first satellite system in 2025. A secondary mission objective for this system of two satellites is to provide the amateur radio community with a single-band VHF repeater on orbit which operates like terrestrial VHF repeaters in the 2-meter amateur band. The cross-band transceivers on these two spacecraft will operate together, using a UHF cross-link, to provide a single-band VHF digital repeater. Their separation distance will be adequately managed with onboard propulsion to avoid de-sensing the receiver on the satellite that provides the input for this on-orbit VHF repeater. Such a repeater system will only require a simple amateur radio ground station with a single antenna and 2-meter transceiver, unlike typical cross-band repeaters on orbit which require two antennae and a cross-band transceiver on the ground.

To demonstrate this type of on-orbit repeater system and promote this UND satellite system across North Dakota, the UND Space Operations Group (SOG) will build and fly a high-altitude balloon (HAB) mission involving two separate balloons that provide the same functionality as this future satellite system. Each HAB will carry a cross-band transceiver not unlike the future satellite system. Working together, the two transceivers will provide a single-band digital repeater that operates like terrestrial VHF repeaters in the 2-meter amateur band. Figure 1 illustrates this single-band dual-balloon repeater concept. This will be SOG's first major near-space mission, fostering this research group's near-space hardware, software, and operations abilities, and enhancing its ability to develop and conduct future space missions.

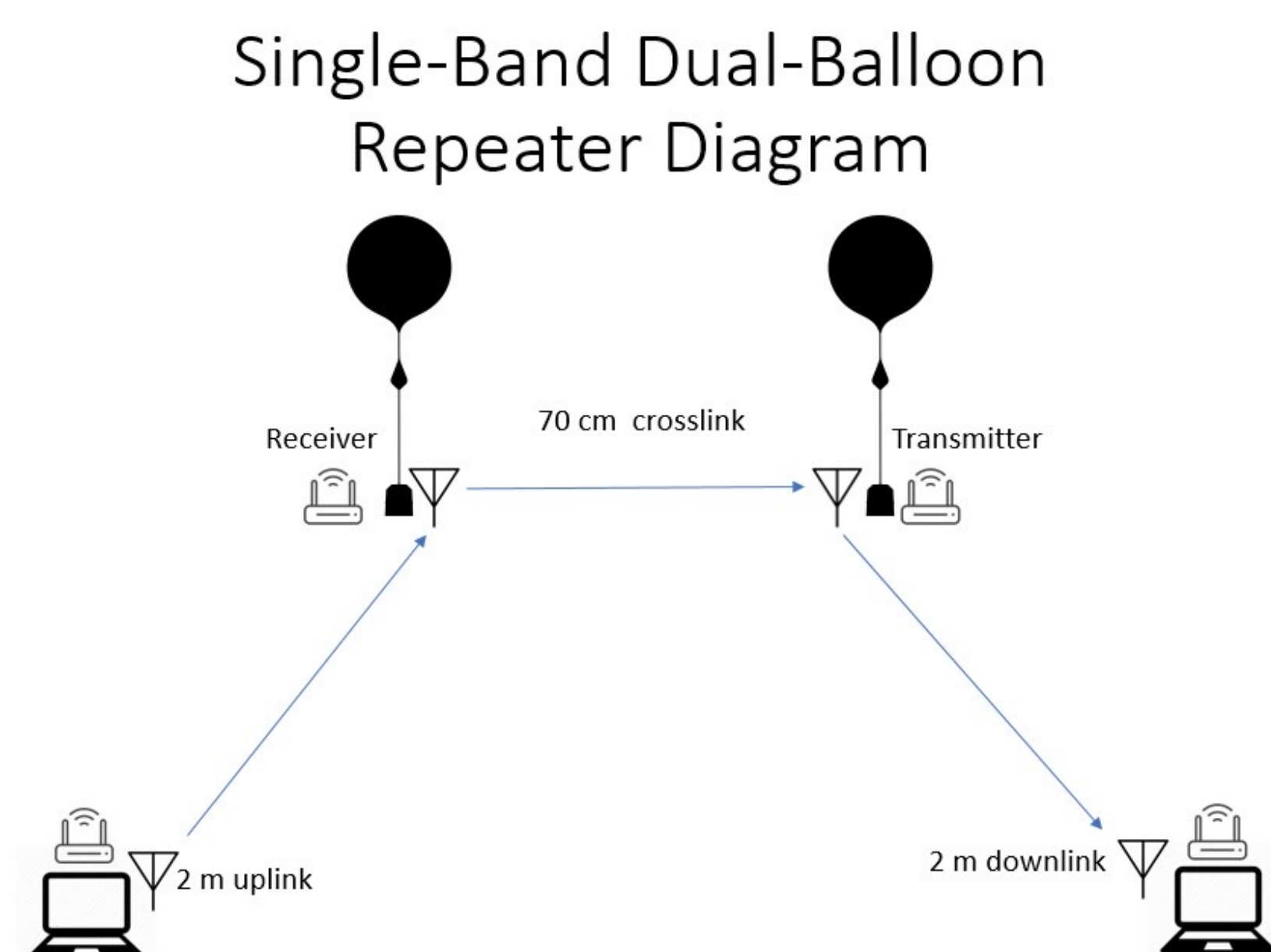


Figure 1: High-level diagram of mission operations

METHODOLOGY

Two GD-88 DMR radios will be used onboard each balloon payload. This dual-band radio has cross-band repeat and same-frequency repeat functionalities. They will be configured on the ground. Radio 1 will receive digital voice on 2 m and re-transmit on 70 cm to the other radio. Radio 2 will receive on 70 cm and re-transmit on 2 m, thus providing single-band repeat functionality. In addition to the radio, the payloads will consist of hand warmers and tracking devices. 600 g balloons will be used along with parachutes and radar reflectors.

The balloons will be launched near the geographical center of North Dakota to maximize the range of the repeater for the ND amateur radio community. Chase vehicles will transmit digital voice, while other individuals will be strategically placed to receive the repeated signal.

FIELD OPERATIONS AND OBJECTIVES

- Dual-balloon flight launched near geographical center of North Dakota
- One radio will be configured to receive on 2 m while the other radio will transmit on 2 m
- Chase vehicles will track both balloons via the SPOT Trace and the Strato Track
- Chase vehicle radio operators and members of the amateur radio community across North Dakota will have the opportunity to use the repeater
- Recovery team will be equipped with the proper gear suitable for the ND/MN summer such as a boat and PFDs



Previous UND Space Studies HAB flight in March of 2023. Balloon was launched from the UND campus as opposed to the planned flight which will launch at a remote site.

PROGRESSION

Planning a predecessor mission as a field test: a TYT UV8000E Dual Band Handheld Radio will be flown on a single-balloon flight as a repeater to test SOG's HAB operations before conducting this mission. The payload for this flight and the overall balloon train should remain identical except for the radio itself. The primary difference between the TYT and the GD-88 is that the TYT handheld is not DMR. In addition, the TYT does not have same-frequency or same-band repeat functionality. We plan on testing the payload in a thermal vacuum chamber for temperature monitoring. In addition, we plan on testing the range of the provided antenna by driving the appropriate distance on the ground and using the Odegard Ground Station (OGS) as the site of the repeater.

UND has ambitions to expand crossband repeater functionality in a CubeSat payload, inviting new opportunities for students in the Department of Space Studies and amateur radio operators around the world. The satellite will be operated by student flight controllers at OGS and will serve as a valuable hands-on learning experience for students at UND.



UND HAB flight in March of 2023 immediately after release from Clifford Hall parking lot