Form 442 Question 7: Experimentation Description

If all the answers to Items 4, 5, 6 are "NO", include as an exhibit a narrative statement describing in detail the following items:

a. The complete program of research and experimentation proposed including description of equipment and theory of operation.

b. The specific objectives sought to be accomplished.

c. How the program of experimentation has a reasonable promise of contribution to the development, extension, expansion or utilization of the radio art, or is along a line not already investigated.

The team is engaged in the NASA CubeQuest Challenge, a NASA Centennial Challenge. The nature of this challenge is to prove navigation to either Lunar orbit or deep space (at least 4 million kilometers from Earth) and establish communications directly to Earth without the use of relays from a 6U CubeSat.

To accomplish this mission, the team intends to navigate to deep space while transmitting data packets from the onboard communications system to the NASA Deep Space Network (DSN) using S-band.

Launching from Cape Canaveral on September 30th, 2017, the NASA Space Launch System mission SLS-EM1 is testing the Orion Manned Module as the primary mission and launching a number of 6U CubeSats as part of its secondary mission. The Team Miles craft is deployed from SLS 411,900 km from Earth, at 7 days 0 hrs 16 minutes into the flight.

The craft performs system checks and orients itself favorably for solar power and communications. It remains in this mode until day 10 of the SLS mission, slightly less than 3 days from the earliest deployment at Bus Stop #5.

At SLS day 10, or deployment +3d, the craft begins 60 days of orbit change maneuvers, ending at SLS day 70, or deployment +63d. During this phase of operations, the craft will be transmitting during four hour windows every 24 hours over the specified frequency at 6k baud.

From that point forward, the craft orients itself favorably for solar power and communications (actually the same pose and logic used after deployment), where it remains communicating until SLS day 200, or deployment +193d. During this phase of operations, the craft transmits continuously at 210 baud. At the end of this phase, the craft drains all potential energy from the electrical system and shuts down in a stable helio-centric orbit between Earth and Mars.

Communications will be accomplished using the following equipment.

Item Name	Item Description	Quantity	Manufacturer	Part/Model Nbr
S-Band Transceiver	Radio - Ettus USRP B200mini	1	Ettus	784415-01
Transceiver case	Steel thermal shroud	1	Ettus	785280-01

Transmit Antenna	Antenna - PCL Nomex	1	Printech Circuit Laboratories Ltd	Nomex
Low Noise Amplifier	LNA - MiniCircuits	1	MiniCircuits	ZX60-P33ULN+
5W Power Amplifier	PA - WENTEQ	1	WENTEQ	AHP0230-09-3537
Reference	10 MHz Reference Oscillator, Leaded, SMT, A phase, B temp, A stability, B 5V, A sine, 10MHz	1	Bliley	LP62AAAABA1M0

Table 1 CubeSat Tranmitter Equipment

Team Miles will utilize the NASA DSN. The following 3 DSN locations will be utilizing a 70m dish, at a minimum 30-degree elevation:

Ground Station Goldstone Station
Latitude: 35.60439774042807
Longitude: 243.112670216
Location: Mohave Desert, Barstow, California. USA

Ground Station Madrid Station
Latitude: 40.61895079468376
Longitude: 355.750833
Location: Madrid, Spain

Ground Station Canberra Station
Latitude: -35.58308544261114
Longitude: 148.981667
Location: Canberra, Australia

A backup Ground Station is provided by ATLAS, located in Ghana. This Ground Station is part of their NOAA implementation.

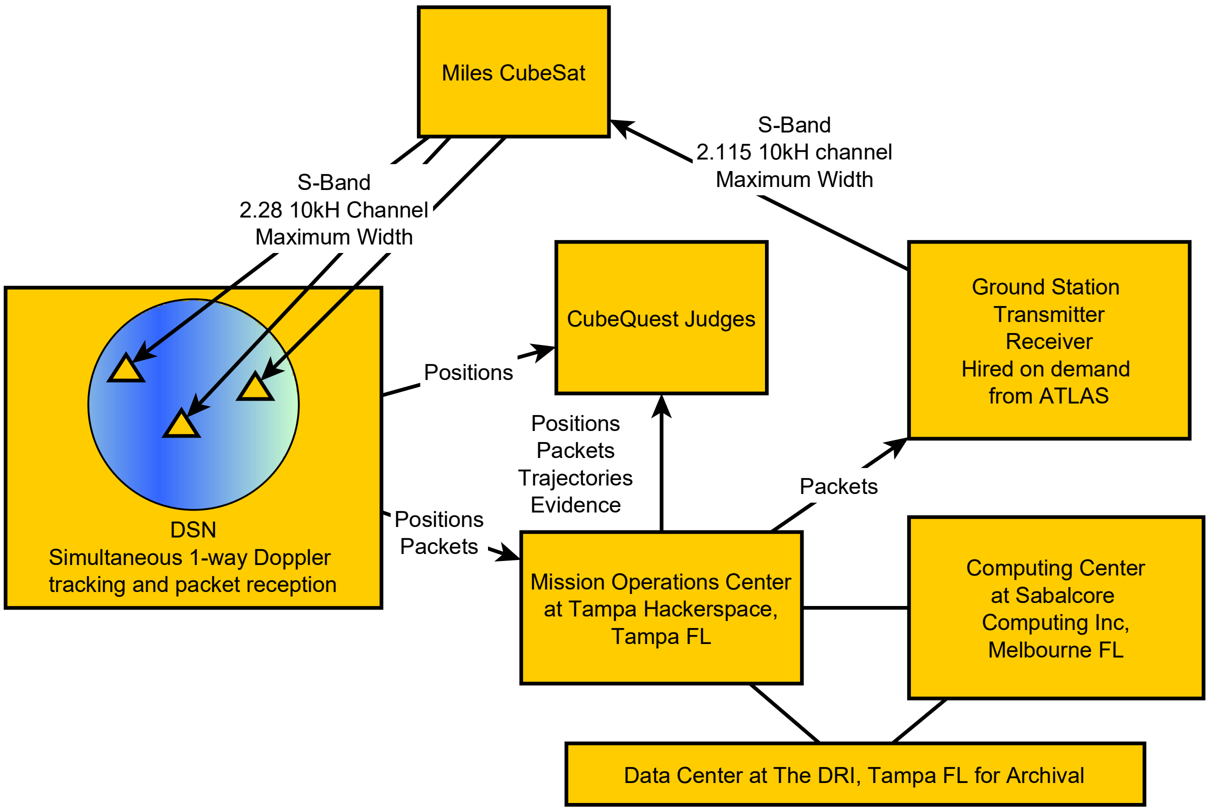

Table 2 Ground Systems Diagram

This mission will demonstrate unprecedented communications ability from deep space for a craft of this size. NASA has, and continues to, communicate with probes at far greater distances. However, these probes (e.g. Voyager) mass about 1000 kg and broadcast at much higher power levels. The CubeSat we are testing measures merely 60x20x30 cm with a total mass of 14 kg. Demonstrating navigation and communications in this diminutive form factor opens the doors to space exploration and science payloads that cost substantially less than currently available options making such exploration cost effective and spurring new missions that were not previously practical.