Exhibit 1: Statement of Research Project

Introduction

Students for the Exploration and Development of Space (SEDS) at the University of California: San Diego (UCSD) is a pre-professional undergraduate organization dedicated to designing, building, and testing additively manufactured rocket engines and small satellite structures. Specifically, small satellites are considered to be a rapidly growing industry due to their combined low cost and high capabilities, especially in lunar and deep space distances.

In order to expand the research of these CubeSats, NASA has declared a second Centennial CubeQuest Challenge to consider different approaches for maintaining highly efficient and advanced operations near and beyond the moon. Therefore, SEDS@UCSD is approaching this challenge by building Triteia: a 6U configuration CubeSat designed to achieve a polar lunar orbit from a trans-lunar injection trajectory through the SLS Exploration Mission 1 secondary payload deployment sequence. Triteia will be utilizing an additively manufactured Hydrogen Peroxide blowdown propulsion unit and ultimately would be one of the first of its kind to evolve away from the conventional electric propulsion thrusters.

Mission Objectives

The CubeQuest Challenge will take place on 2018 and will last a duration of 365 days after the launch of the SLS Exploration Mission 1. Under the assumption the Triteia project team wins the remaining Ground Tournaments in the CubeQuest Challenge, the spacecraft will secure a secondary payload spot on NASA's SLS launch vehicle. In order to actively advance the capabilities needed to take humans farther into space, Triteia is currently developing a stable communications system to achieve lunar propulsion by performing one verifiable Lunar Orbit and maintaining the greatest communication distance, as well as achieve spacecraft longevity by maintaining the longest elapsed number of competition days between the first and last confirmed reception. Triteia also plans to advance capabilities of additively manufactured rocket engines for space travel and of the use of small satellites to further the planetary sciences.

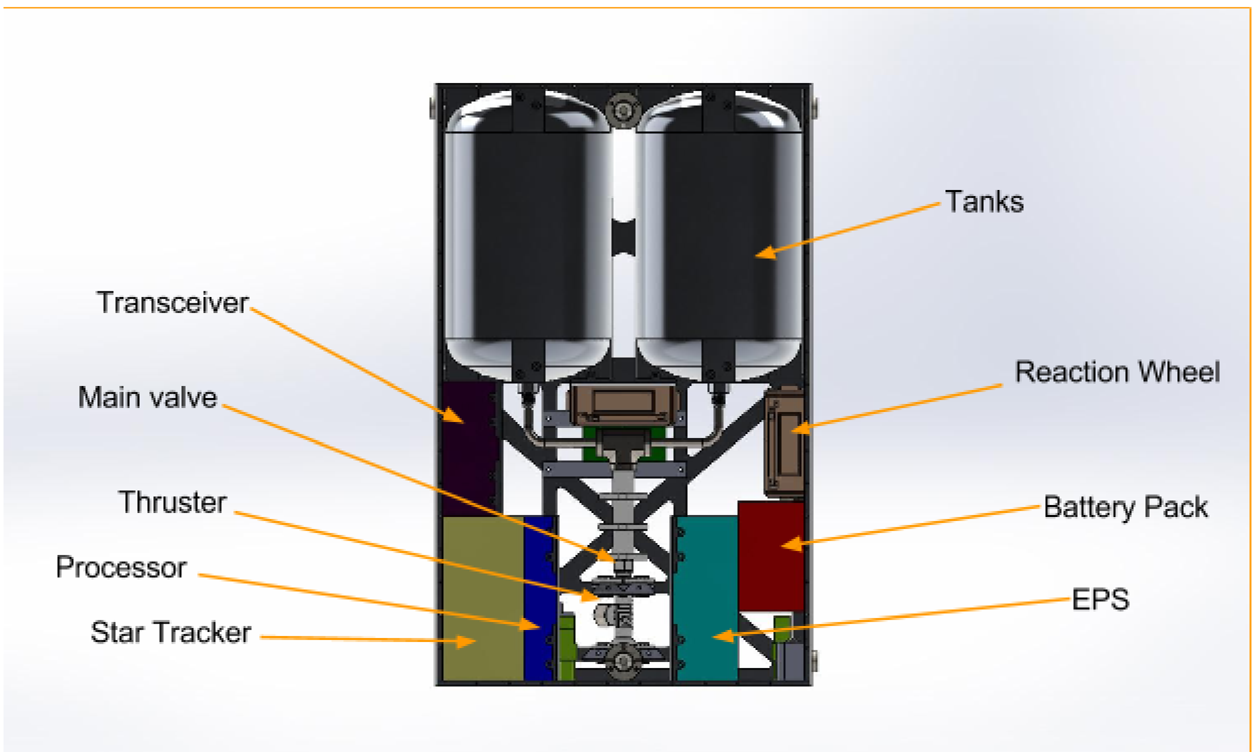
Triteia will also perform in-space experiments and demonstrations as secondary mission objectives. These include analyzing real-time thruster performance data from its monopropellant engine and reconciling it with measured calculations for future additively manufactured thruster actuation publication, as well as testing new propulsion control algorithms to demonstrate sensor value responses obtained from its engine performance data, such as changing temperatures and varying pressures, and how they correspond to environmental perturbation. With regards to its electrical control algorithms, Triteia's power systems architecture will be running a series of experiments for its optimization mechanism between communication rates, power input, and thermal state in order to maximize aggregated wattage efficiency across all power sinks. Triteia will also perform an array of experiments that test new technologies pertaining to advanced radio-frequency communication relays, navigation signals/processing and attitude control determination methods.

FCC Proposal Statement

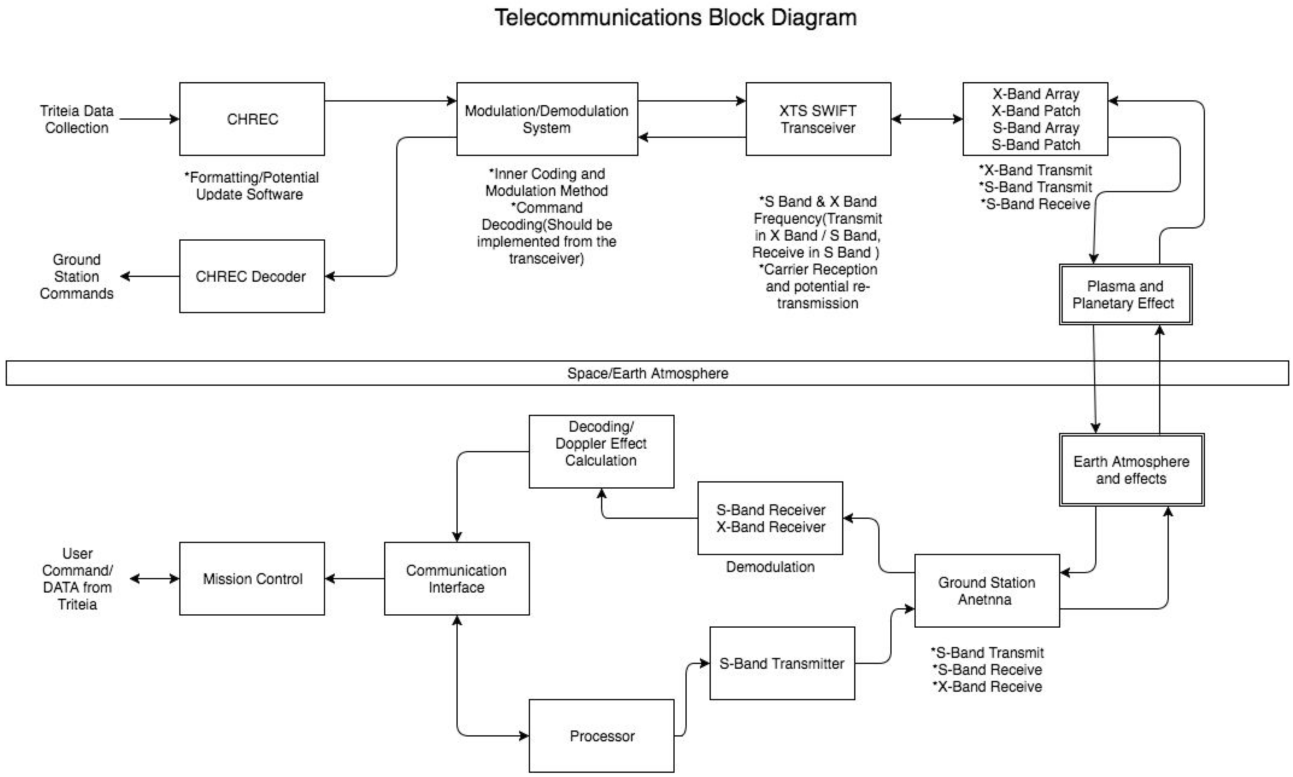
To successfully accomplish Triteia's mission objectives, we request a license utilizing frequencies for 2056 MHz S-Band uplink, 8250 MHz X-Band downlink, and 2185 MHz S-Band downlink.

Spacecraft Description

The main driving system requirement is to achieve lunar orbit, while advancing the state of propulsion by using additive manufacturing and verifying communication capabilities with the goal of maintaining operational power and thermal states. Triteia is a 6U CubeSat, 366x239x116 mm, with 4 solar panel arrays. The main chassis is composed of Aluminium 7075-T6, a material chosen for its balance between strength and lightness. It contains a Li-ion battery pack, 3 reaction wheels, S/X-Band transceiver, a S and X-Band patch antenna, a S and X-Band patch antenna array, an electrical power system, microprocessor, star tracker, 7 coarse sun sensors, thruster, two fuel tanks, 4 main valves and piping. About half of the spacecraft volume is occupied by two tanks for propellant.



Communications System



Telemetry and Frequencies

When choosing the most ideal frequency band for satellite command, navigation, and telemetry, corresponding limitations due to legal bandwidth accessibility, electromagnetic interference, and free-space path loss (FSPL) must be taken into consideration, especially when performing in lunar orbit. After extensive research on such limitational compromises and ground station capabilities, Triteia's communication channel will require the uses of S-Band uplink 2056 MHz, X-Band downlink 8250 MHz, and S-Band downlink 2200 MHz for transmitting and receiving between Triteia's SWIFT XTS Transceiver and ATLAS Space Operations Ground Station. Since these frequencies are within range of the federally owned allocations, they were deemed conditionally safe for Triteia's primary mission objectives.

Due to their enduring reliability from previously successful deep-space NASA missions, these frequencies were deemed most ideal for allowing Triteia to perform its in-space secondary experiments as well. Acknowledging chances of unpredictable environmental changes within the Earth's atmosphere, the S-Band uplink/downlink and X-Band downlink will also serve as a robust bandwidth connection between its dedicated path loss mitigation and highest data rate without compromising feedback margins. It is important that the frequency range allows for unhindered, communication through the atmosphere in all weather conditions which is necessary for establishing data blocks with an operating satellite. Utilizing X-Band to transmit data from the CubeSat also has the advantage of high data rates and bandwidth efficiency with accuracy from our ground station as a tradeoff. Transmitting in X-Band from the spacecraft would be advantageous for sending images and other information to the specified earth station while transmitting in S-Band could be used to send CubeSat system data. It is also essential to choose an adequate modulation method for telemetry data because of its impact in the reliability, power, and bandwidth efficiency of the communication system as a whole. Triteia will be utilizing BPSK (Binary Phase Shift Keying) due to its overall advantage in bandwidth. Although its capabilities make it difficult for high data rates, we plan to adjust our antenna effectively to handle the side effect.

These frequencies are necessary for adequate transmissions to Triteia as it performs a lunar orbit. It is also compatible with Triteia's chosen transceiver and ground station.

CubeSat Telecommunications Subsystem

The on-board communication system will be controlled with Tethers Unlimited SWIFT XTS S/X[1] Transceiver to board all of Triteia's command and data relaying system, telemetry interface function, radiation-hardened recorder, and embedded telecommunications receiver/exciter amplifiers system, along with the DC-DC converters which power them all. It was chosen above other options because of its S/X capabilities, programmability, and proportion of size to high data rates combined with its low power budget. It's focus as a high powered X-Band transmitter allows the system to transmit images and use software efficiently without much interference; hence, due to future considerations for a possible image processing secondary-mission objective, this SWIFT XTS was settled upon. Similarly, the ideal uplink and downlink frequencies for the communications system are within the aggregated range of the transceiver. Furthermore, in regards to its physical structure, the sheer small size and weight of the transceiver itself promises ideality for Triteia's chassis compaction. The transceiver is also ideal for programming configurable parameters for the Triteia communication subsystem. The operating temperature of the transceiver, -40° C and +85° C, is also adequate for the spacecraft in space.

The other essential components to the central subsystem on the spacecraft are the X-Band patch antenna, S-Band patch antenna, S-Band array, and the X-Band array. The patch antennas are comprised of both substrate and copper materials. The reason the patch antennas and array components were chosen was to minimize size as well as maximize concentrated gain. Using a patch antenna gives the satellite the capability to establish a reliable link margin from lunar orbit. A vector network analyzer (VNA) as well as an anechoic chamber will be used to test the two patch antennas and determine the impedance, return loss, and efficiency levels.

ATLAS Space Operations Telecommunications Subsystem

Tritea will be utilizing ATLAS Space Operations[2] as the centralized ground station and the main system of communication to and from the CubeSat. ATLAS Space Operations provides a 7.6m Omnispace Satellite Antenna capable of receiving in X-Band and transmitting and receiving in S-Band. The receive frequency utilized is 8.25 GHz in X-Band and 20170-2200 MHz in S-Band. The transmit frequency utilized is 2056 MHz in S-Band. Their antennas are licensed for XMIT in S-Band and RCV in X-Band.

[1] http://www.tethers.com/SpecSheets/Brochure_SWIFT_XTS.pdf
[2] http://www.atlasground.com/

Safety Standards

Orbital Debris Plan and Procedures

The space station should not release debris over its lifespan. All components will be secured onto the chassis and until impact on the lunar surface. More information on disposal plans can be found in Post Mission Disposal Plans and Procedures.

The probability of becoming a source of debris through collisions with large objects in orbit is low because of the space stations polar orbit of the moon which differentiates itself from other satellites following a stable non-polar orbit of the moon.

The probability of collisions with small debris and meteoroids is low. The highest probability of collision will be during the travel to the moon. However, Triteia will be inside the SLS prior to orbit insertion. Furthermore, while in polar orbit, there is few orbital debris. Thus the probability of collision with small debris is small.

Accidental Explosion Procedures

Collaboration with NASA engineers ensures that accidental explosions with the Triteia propulsions system has very limited probability of occurrence. Energy sources such as chemical, kinetic, and pressure will be removed at the end of the spacecraft's lifespan. Any residual fuel will be depleted and batteries will be discharged.

Coordination with SLS Procedure

Prior to the launch of the SLS, Triteia will collaborate with NASA to coordinate the insertion of the Triteia spacecraft into space from the SLS. However, one the SLS releases Triteia into space, SLS will perform the appropriate maneuvers to avoid collision through unique remote control. To avoid RF interference, Triteia will refrain from transmitting until 45 seconds after release. No other communication with the NASA subsystem is needed after Triteia is deployed. Triteia will follow a polar lunar orbit separate from the SLS.

Post Mission Disposal Plans and Procedures

GMAT simulations show that after approximately 425 days of normal operation, the spacecraft deorbits passively and impacts the lunar surface without the need for additional maneuvers. However, in the event of an imminent collision with an historic lunar artifact, the spacecraft has an error margin of 81.8 m/s built into the delta-v budget that can be used to alter the trajectory and impact at a safer location. No solid objects (>1 mm) are expected to be released from the spacecraft any time after launch. There are no intentional breakups scheduled during orbit operations, nor are there any known potential causes of spacecraft breakup during mission operations.

Figure 1: Apolune and perilune over lifetime of orbit; evidence of surface impact