CHOMPTT Satellite Technical Description

The overall goal of the CHOMPTT (CubeSat Handling of Multisystem Precision Time Transfer) mission is to synchronize an atomic clock on a CubeSat with one on the ground with an accuracy of 200 picoseconds by exchanging short laser pulses between the two (emitted from the ground, and reflected by a CubeSat retro-reflector).

The satellite will be launched aboard the RocketLab Electron Rocket, from Mahia, New Zealand, no earlier than May 22, 2018. It will be inserted into an orbit at 500 km apogee and 500 km perigee, at an inclination from the equator of 85 degrees. Transmission will begin 30 minutes after deployment, and cease at mission end after 12 months. Atmospheric friction will slow the satellite and reduce the altitude of the orbit, until de-orbiting occurs approximately 4 years after launch. See the Orbital Debris Assessment Report for details.

The satellite is a single 3U CubeSat with dimensions 10 cm X 10 cm X 34 cm and total mass of 3.96 kg– see Figure 1.

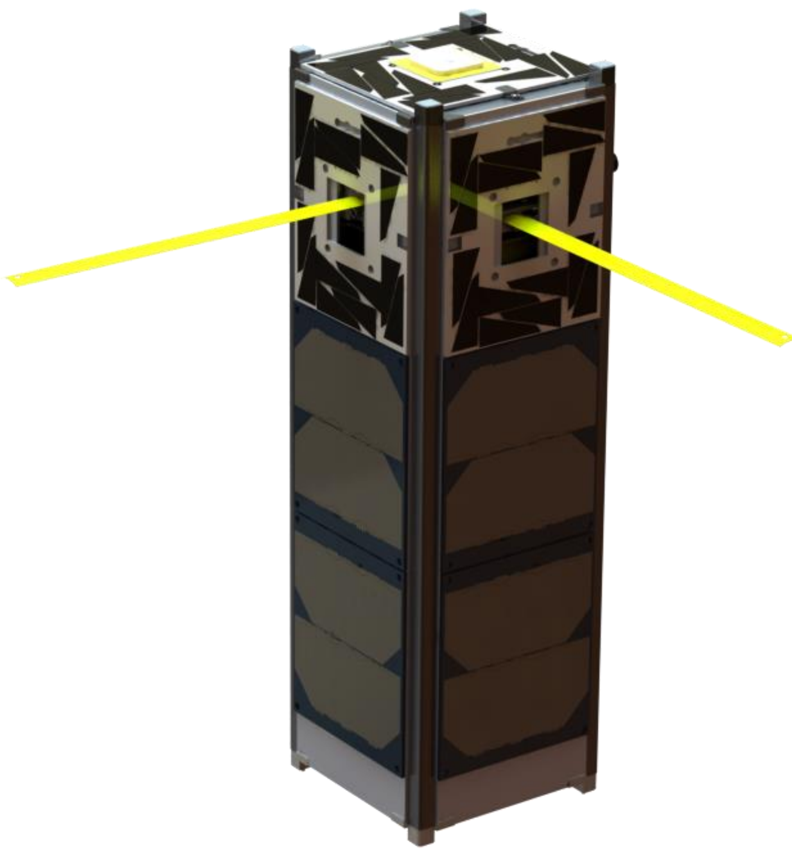

Figure 1 - CHOMPTT Overview

The expanded view of the satellite is shown in Figure 2.

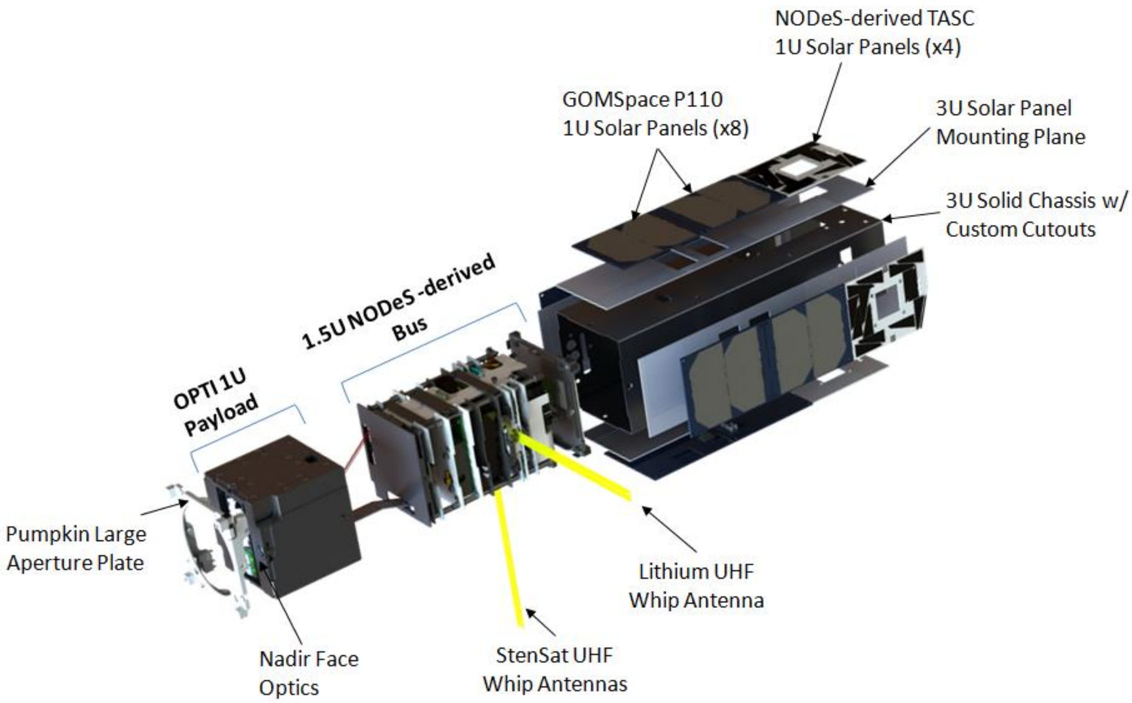

Figure 2 - CHOMPTT Satellite Expanded View

The CHOMPTT satellite contains the following subsystems:

Command and Data Handling Subsystem: The C&DH uses a Nexus S smartphone as the main processor with additional distributed Arduino processors for running other activity tasks such as interfacing with the payload, polling sensor data, and interfacing with the GPS. A parallax propeller chip is used to route data around the satellite between the smartphone and the peripheral Arduino processors. The C&DH also includes a watchdog timer to limit radio transmissions if command from Earth is lost.

Attitude Determination and Control (ADCS) Subsystem: The ADCS consists of three orthogonal reaction wheels and torque coils embedded in the solar panel Printed Circuit Boards (PCBs). Attitude determination uses a magnetometer sensor combined with coarse sun sensors embedded in the solar panels. The ADCS has two distinct modes of operation. The first is magnetic control, and is used to detumble the spacecraft and align it with the local magnetic field for GPS acquisition and downlink activities. The second is 3 axis control and uses the reaction wheels and attitude determination to point the CubeSat nadir, enabling laser time synchronization with the payload and satellite laser ranging facility (SLR).

Electrical Power Subsystem (EPS): The power subsystem consists of the body mounted solar arrays, rechargeable lithium ion 18650 battery storage capable of sustaining subsystems during operating loads and orbit eclipses, and the remove before flight and separation switch power inhibits.

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Communication Subsystem: The CHOMPTT communications subsystem uses two radios.

Two way ground communications with the University of Florida ground station is performed with an Astrodev (Astronautical Development, LLC) Lithium 1 UHF transceiver, with a deployable tape-measure monopole antenna. The Uplink and downlink occur at 9600 bit/s under the AX.25 protocol. The Astrodev transceiver is only powered when an uplink and downlink is scheduled over the ground station. Once an uplinked command is received by the satellite from the ground station, the satellite will begin to transmit. All radio communications can be disabled with a kill command during this scheduled event

A StenSat UHF transmitter using a similar antenna, sends beacon packets of data every 60 seconds at 1200 bits/s. The StenSat and the Lithium 1 will not transmit at the same time.

All communication between the CHOMPTT satellite and ground (both uplink and downlink) is enabled 30 minutes after being deployed from the dispenser. A dead man timer inhibiting all satellite communications will be activated if no commands are received by the satellite for 18 consecutive days.

Thermal Control Subsystem (TCS): There is no active thermal control on the spacecraft bus. The avalanche photodiode (APD) on the payload has a built-in thermo electric cooler that regulates the temperature of the 200 µm active area of the APD. The APD is only on during a ground-scheduled pass over the satellite laser ranging facility at the Townes Institute of Technology and Experimental Facility located at the Kennedy Space Center, lasting approximately 10 minutes.

Structure Subsystem: The structure is a 3U solid-walled chassis with custom cut-outs to accommodate the spacecraft bus and payload, fabricated of aluminum 6061.

Propulsion Subsystem: No propulsion subsystem is included.

Payload Subsystem: The CHOMPTT satellite will maintain its time with a chip scale atomic clock. When the satellite passes over the satellite laser ranging facility (SLR), the SLR emits a laser pulse toward the satellite. That pulse is time-stamped with respect to the ground clock and after it reflects from a retroreflector on the satellite, the reflected pulse is time-stamped upon arrival back at the SLR facility. An avalanche photodetector on the satellite simultaneously detects the pulse's arrival time and records the event, time-stamped with respect to the clock on the satellite. The combination of these three timing measurements provides both the range between the SLR and CHOMPTT, and the time offset between the ground clock and the space clock.