CHOMPTT (CubeSat Handling of Multisystem Precision Timing Transfer): From Concept to Launch Pad

POC/Presenter: Seth Nydam, stnydam@ufl.edu, University of Florida

Authors:
Jeremy Anderson, Nathan Barnwell, Maria Carrasquilla, Jonathan Chavez, Olivia Formoso, Asia Nelson, Tyler Noel, Seth Nydam, Jessie Pease, Charles Pett, Frank Pistella, Tyler Ritz, Steven Roberts, Paul Serra, Evan Waxman, John W. Conklin
University of Florida, Gainesville, FL 32611, U.S.A.

Watson Attai, , Ashley Clark , John Hanson, Anh N. Nguyen, Cedric Priscal, Jan Stupl, Jasper Wolfe, Belgacem Jaroux
NASA Ames Research Center, Moffett Field, CA, 94035, U.S.A.

Abstract
Here we present the evolution of a student satellite mission: CHOMPTT (CubeSat Handling of Multisystem Precision Time Transfer), from its original concept as a candidate for the University NanoSatellite Program 8 (UNP8), to a spacecraft ready for launch in Fall of 2017 on ELaNa XIX (Educational Launch of Nanosatellites). The 3U CubeSat houses a 1 kg, 1U OPTI (Optical Precision Timing Instrument) payload, designed and built at the University of Florida, and a 1.5U EDSN/NODeS-derived bus from NASA Ames Research Center. The OPTI payload comprises of: 1) a supervisor board that handles payload data, power regulation, and mode settings, 2) an optics assembly of six 1 cm retroreflectors and four laser beacon diodes for ground-tracking; and 3) two fully redundant timing channels, each consisting of: a chip-scale atomic clock, a microprocessor with clock counter, a picosecond event timer, and an avalanche photodetector (APD) with band-pass filter. Several iterations of OPTI have been developed, tested, and designed to achieve its current functionality and design – a laboratory breadboard design, a 1.5U high altitude balloon design, engineering unit design, and its current flight unit design. In-lab testing of the current OPTI design indicates a short-term precision of 100 ps, equivalent to a range accuracy of 3 cm necessary to achieve our primary objective of <200 ps time transfer error, and a long-term timing accuracy of 20 ns over one orbit (1.5 hours). After the spacecraft reaches its nominal 500 km orbit at a 85 degree inclination, an experimental laser ranging facility at Kennedy Space Center in Florida, will track and emit 1064 nm nanosecond optical pulses at the CHOMPTT spacecraft. The laser pulses will then reflect off the retroreflector array mounted on the nadir face of CHOMPTT, and return the pulse to the laser ranging facility where the laser ranging facility will record the round-trip duration of the laser pulses. At the same time the pulse arrives at the spacecraft and is reflected by the array, an APD will record the arrival time of the pulses at the nanosatellite. By comparing the arrival of the pulse at the CubeSat and the duration of the round-trip of the laser pulse, the clock discrepancy between the ground and CubeSat atomic clocks can be determined, in addition to the CubeSat's range from the facility. The design and verification of the flight version of CHOMPTT will be reviewed and an overview of the lifetime development and progression of CHOMPTT from the inception to launch pad will be presented.

Topic: Next on the Pad