University of Massachusetts Lowell SPACE HAUC Cubesat
Technical Description

The goal of SPACE HAUC mission is to provide undergraduate students with an opportunity to work on a satellite project, and demonstrate practicality of a student developed high data rate (50-100 Mbps) X band communication system, with beam steering capability using a phased array antenna.

The satellite will be launched as a secondary payload from Wallops Flight Facility, No Earlier Than August 1, 2021, and carried to the International Space Station (ISS). It will be deployed from the ISS into an orbit of about 400 km circular, on an inclination from the equator of 51.6 degrees. Power up of systems will initiate upon deploy from ISS, and 30 minutes after that, antennas and solar panels will be released from stowed to flight positions.

Attitude stabilization is expected to require about 2 days after deploy, and after that, when a signal is received from the ground station, transmission will begin. Atmospheric friction will slow the satellite and reduce the altitude of the orbit, until de-orbiting occurs in 1 to 2 years after deployment. See the Orbital Debris Assessment Report for details.

The spacecraft is a 3U cubesat with overall dimensions of 34 cm X 10 cm X 10 cm. The total mass is about 3 Kg.

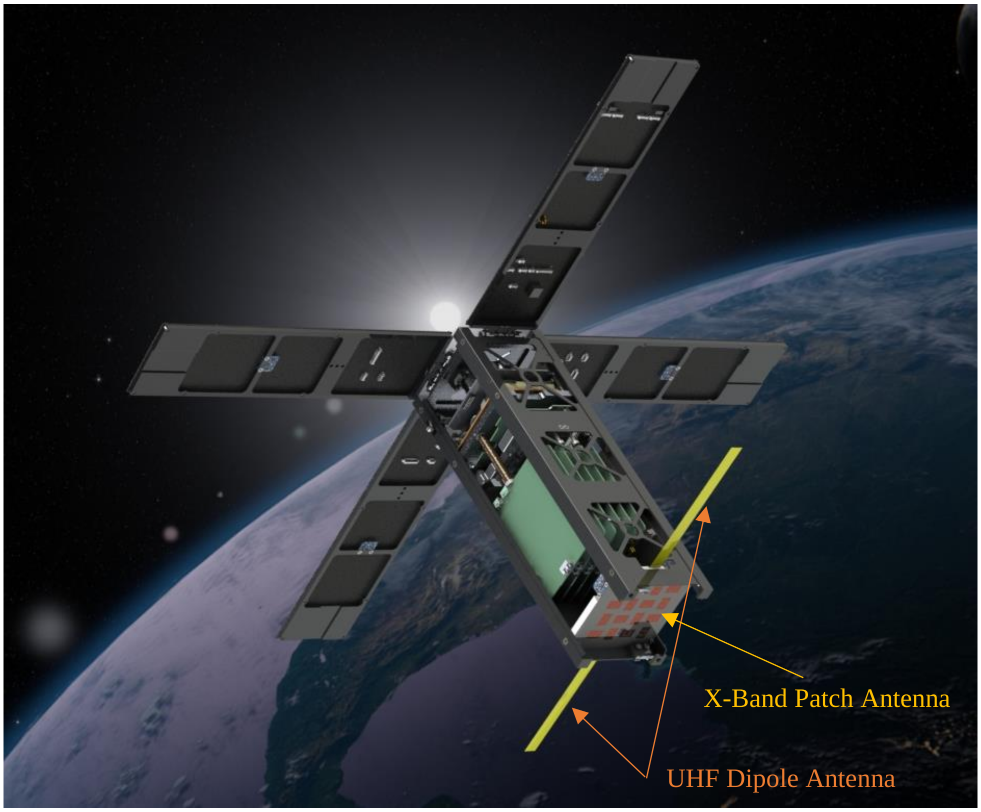

Figure 1: SPACE HAUC In Orbit (Artist Rendering)

The satellite contains the following systems:

<u>Attitude Control System (ACS):</u> The ACS subsystem utilizes a magnetometer, nine coarse sun sensors, a fine sun sensor, and three magnetorquers to stabilize and orient the spacecraft. The magnetometer, magnetorquers, and control devices for magnetorquers are mounted on a PCB. The first task of ACS is to detumble after the solar panels have been deployed. The detumbling control uses feedback from the on-board magnetometer, sensing the magnetic field of the Earth. Once detumbled, the 'sun pointing' control mode is initiated - the solar panels are pointed to the sun.

Command and Data Handling (CDH) Subsystem: The CDH subsystem controls all subsystems by controlling and tasking each subsystem as needed. The processor is used to control all subsystems on spacecraft. The processor is programed to allocate power from the batteries to subsystems, programming devices for deployment system, attitude control system, thermal system, communication systems, and camera.

Communication Subsystem: The communication subsystem includes two radios – a UHF radio for telemetry and command, and an X-band radio and antenna that comprise the payload. The X-band system is further described in the Payload Subsystem section. The UHF system utilizes an EnduroSat UHF Type II transceiver, and a deployable 'tape-measure' antenna. The UHF ground station is located on the UMass Lowell campus, and uses a Yagi antenna for 2-way comms with the spacecraft.

Power Subsystem: The Power subsystem consists of four 3U Solar Panels from EnduroSat, a battery pack, and an electrical power supply (EPS)—NanoPower P31u from GOMSpace, to generate and supply power to subsystems within the spacecraft. The Solar Panels are capable of generating around 8.5 watts power from each solar panel. The NanoPower BP4 battery pack, is a Lithium-Ion four cell pack with 38.5Wh capacity,

Propulsion Subsystem: The spacecraft has no propulsion capability.

Structure Subsystem: The structural bus of the spacecraft is fabricated of Aluminum 7075-T6, 18-8 and 316 steel securing hardware. The outside of the structural bus is black hard anodized to prevent cold welding while inside the deployer, and to isolate charge build up on outside of the spacecraft from internal components.

Thermal Subsystem: Thermal subsystem manages cycling of the on-board electronic components based on the temperature of devices, to ensure no device is overheated. The system uses temperature sensors on all boards, and thermal straps from the boards to a radiator. In addition, parts of the spacecraft surface have multi-layer insulation attached.

Payload Subsystem: The payload of the spacecraft is a student designed and built X-band phased array communication system, to demonstrate practicality of high data rate (50-100 Mbps) downlink communication using beam steering. The payload consists of an AD9364 COTS transceiver, student designed transponder boards and an antenna with beam steering capability. The antenna is a 4x4 (16 elements) ultra-wideband patch antenna array forming a 25º beam, and capable of steering the beam ±45º from boresight. To test the data rate, a picture of the sun captured by an on-board camera is sent to the X band ground station receiver at MIT. The ground station transmitter located on the UMass Lowell campus, consists of a parabolic reflector and helical antenna to send an X-Band reference signal to the spacecraft for demonstration of beam steering capabilities. The spacecraft searches for reference signal from the ground station, and detects the phase of incoming signal using time difference in between 2 patch antennae in 2 axes. Once locked to the ground station signal, the spacecraft steers the center line of the antenna beam in the direction of the ground station.