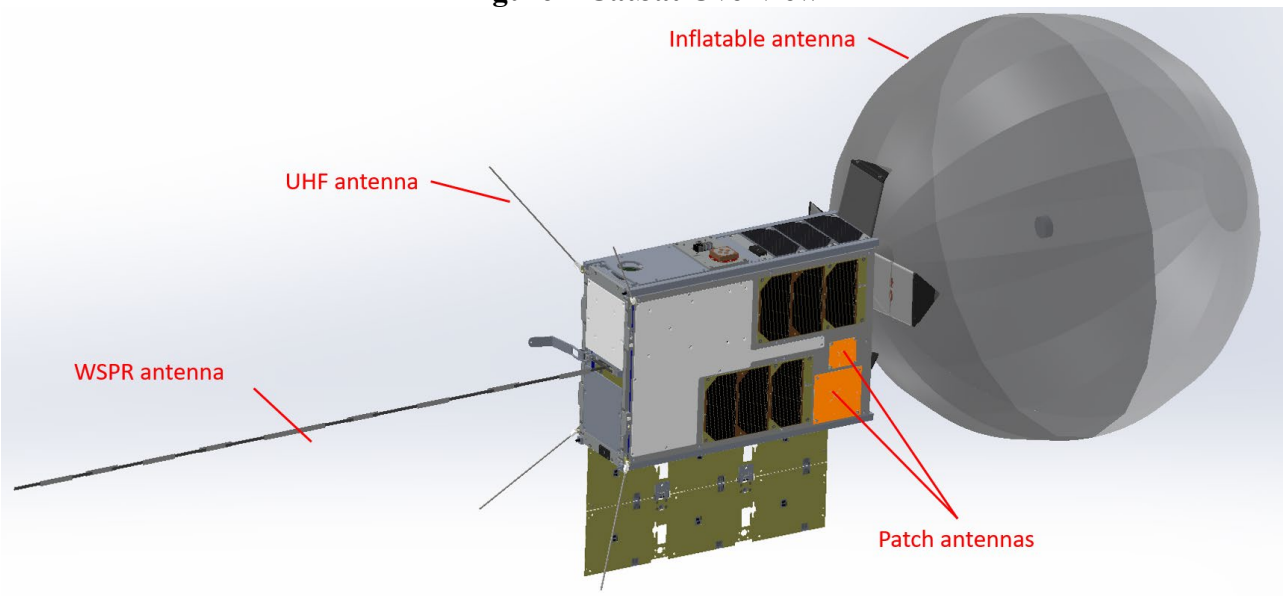
Cat Satellite Technical Description

The goal of the CatSat mission is two-fold. First, to demonstrate the operation and capabilities of a 10 GHz inflatable RF antenna system, which will transmit data to the ground at a rate up to 50 Mbps. The antenna will transmit images of the Earth acquired by a high-definition camera. The second goal of CatSat is to study diurnal ionospheric variations using an HF WSPR antenna. CatSat will also provide a 5 GHz up / 10 GHz down linear transponder service for HAM radio operators. CatSat is a student mission – it has been designed, assembled, and tested by students at the University of Arizona. Correspondingly, a large part of CatSat's mission is educational – getting a new generation of students involved in spaceflight. Moreover, the HF components of the mission will necessarily involve HAM operators across the world, as well as providing a service in the form of the linear transponder.

The satellite will be launched as one of several cubesat payloads aboard the Firefly Black VCLS Demo-2, from Vandenberg Space Force Base, No Earlier Than June of 2022. It will be inserted into an orbit at an altitude of 565 km (circular orbit), on an inclination from the equator of 97.58 degrees. Operation of radios will begin 30 minutes after deploy from the launch vehicle, and cease 2 years later. Atmospheric friction will slow the satellite and reduce the altitude of the orbit, until de-orbiting occurs <15 years after launch. See the Orbital Debris Assessment Report for details.

The spacecraft is a single unit with the dimensions of 6 stacked 10 cm X 10 cm X 10 cm CubeSat modules (giving an overall dimension of 10 cm X 22.5 cm X 34 cm). The total mass is about 7.9 kg.

Figure 1 CatSat Overview



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The satellite contains the following systems:

Guidance, Navigation and Control (GNC) Subsystem: The ADCS is composed of a variety of subsystems, including a set of actuators, sensors, and a dedicated ADCS A3200 flight computer. The ADCS accommodates a NovAtel OEM719 GPS receiver. It uses a NanoTorque GSW600 reaction wheels package, four wheels in a pyramid configuration, providing redundancy against the loss of one wheel. It includes a NanoTorque GST600 3-axis magnetorquer for momentum dumping.

Command and Data Handling (CDH) Subsystem: Command and Control is handled by a Gomspace A3200 Nanomind microcontroller (OBC), which controls data collection and commanding. Attitude Determination and Control is handled by a separate dedicated A3200 Nanomind. Communication between the OBC and ADCS is handled with Cubesat Space Protocol(CSP) over CAN Bus. An additional payload computer, the AstroSDR is connected to the OBC via serial and also communicates using CSP to route commands.

Communications Subsystem (COMMS):

Command and Control (C&C) is communicated to CatSat via its GomSpace model AX100 UHF transceiver and an omnidirectional antenna, operating at 437.185 MHz up and down. The OBC controls the UHF up/downlink.

The AstroSDR transceiver and Kuhne KU UP 107A transmit upconverter receives the 5 GHz uplink via the 5 GHz patch antenna, and transmits the 10 GHz downlink with the inflatable antenna and the 10 GHz patch antenna.

C&C communication is handled by a primary and backup ground station. The primary ground station is at Radio Ranch (private facility; KT7D). The backup ground station is run by the University of Arizona Amateur Radio Club (K7AUZ). Both C&C stations will be equipped to handle uplink of commands and downlink of telemetry and instrument housekeeping.

If no UHF is received by the satellite after a set period, the UHF transmission will be inhibited until a UHF uplink is received.

The downlink ground stations will be at Biosphere2 (operated by the University of Arizona) and UArizona Tech Park (jointly operated by UArizona and Rincon Research). Both stations will have 6.1 meter dishes for 10 GHz data downlink from the spacecraft.

Electrical Power Subsystem (EPS): The EPS includes a GomSpace NanoPower P60 dock, NanoPower P60 PDU, NanoPower BPX battery pack, and AzurSpace 3G30A solar panels. The batteries provide a nominal capacity of 20.8 A-hr. The solar panels are GaInP/GaAs/Ge on Ge substrate assemblies.

Thermal Control Subsystem (TCS): CatSat includes no active thermal control. The cubesat is passively cooled via a patch radiator.

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Structure Subsystem: The CubeSat structure is made of aluminum 6061-T6, supplied by GomSpace.

Propulsion Subsystem: No propulsion subsystem is included.

Payload Subsystem: CatSat's payload subsystems include the inflatable antenna system, HF antenna system, software defined radio, high definition camera, metrology cameras, and patch antennas. The inflatable antenna system, including its controller, is used to provide high bandwidth 10 GHz downlink capability. The HF antenna system includes a WSPR antenna, high frequency upconverter, and Astro Software Defined Radio (ASDR) provided by Rincon Research. The WSPR antenna will be used to probe the ionsphere by measuring the polarization of HAM radio signals received from terrestrial operators. The high definition camera will be used to capture images of the earth at video rates, which will be transmitted to Earth via the 10 GHz downlink. The 5 GHz receiving patch antenna, when used together with the AstroSDR and 10 GHz patch antenna, provides linear transponder functionality for terrestrial HAM radio operators. Two metrology cameras are included for on-orbit imaging during the commissioning phase and monitoring of the inflatable antenna after its deployment.