SilverSat Satellite Technical Description

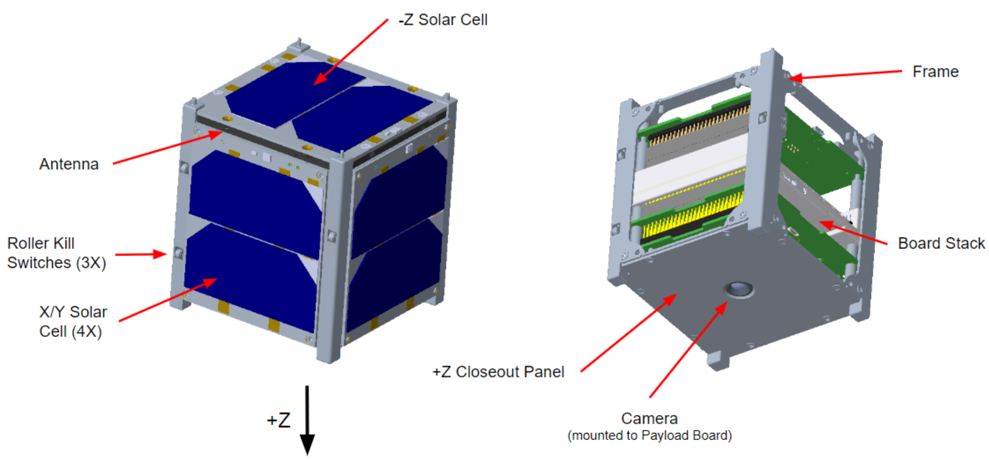
The overall goal of the SilverSat mission is to be an educational mission for middle- and high-school students. This satellite is designed and built by student members of SilverSat with adult mentors. It is a technology demonstration, using emerging Improved Layer 2 Protocol (IL2P) data over amateur UHF frequency to and from the satellite. This extends work that has been done by others with using this protocol for amateur packet radio. SilverSat will employ multiple operating modes for this demonstration.

In SSDV Mode, we will use the Slow Scan Digital Video (SSDV) format to transmit images taken by the satellite. These will be transmitted globally so that operators worldwide can become familiar with the IL2P protocol as well as the SSDV format. All necessary information to receive and process these images will be available on our website. In addition, anyone can request images of a particular location using our website.

In “Tweet from space” mode, the satellite would transmit data in an IP over IL2P protocol. This will transmit photos taken by a camera on the satellite, along with short text. The ground station will forward this data and photos to the media platform X, as tweets. This facilitates outreach to and involvement of those who may not already be involved in amateur radio.

The satellite will be launched as a secondary payload aboard CRS NG-22 ISS cargo re-supply mission, from Cape Canaveral, Florida on June 7, 2025.   It will be deployed from the ISS into an orbit at 413 km apogee and 422 km perigee, on an inclination from the equator of 51.6 degrees. Transmission will begin 45 minutes after deployment. Atmospheric friction will slow the satellite and reduce the altitude of the orbit, until de-orbiting occurs approximately 1 year after launch. See the Orbital Debris Assessment Report for details.

The spacecraft is a single unit with the dimensions of a 1U 10 cm X 10 cm X 11.35 cm CubeSat module. The total mass is about 883 g.



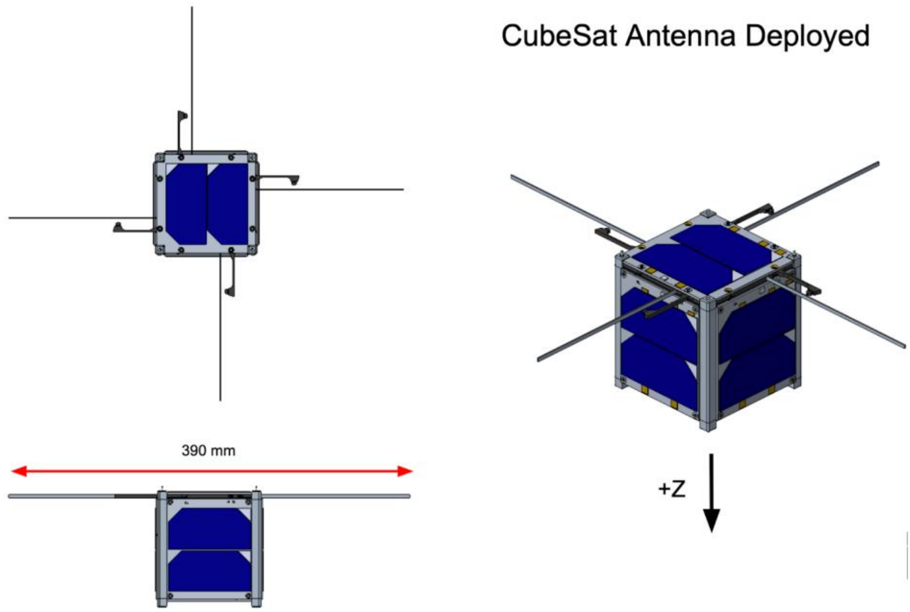


Figure 1 SilverSat Overview

The satellite contains the following systems: Avionics, Comms, Electrical Power, Attitude Control, Structure and Payload. The spacecraft contains no propulsion.

Avionics Subsystem: The Avionics subsystem consists of a single board computer based on the ATSAMD21G18A microcontroller. This board also contains a real-time clock, 6 degree-of-freedom inertial measurement unit (IMU), 32k-byte FRAM, external watchdog timer and e-Fuse. Data communications between Avionics, Payload and the Comms use RS-422. The operations of the Payload (power enable and mode) is signaled between the boards using triple-voted open-drain general-purpose I/O. The IMU is a COTS Adafruit MPU 6050 module, and it detects translational and rotational acceleration to identify whether the satellite is tumbling.

Communications Subsystem (Comms): The Comms subsystem includes one radio and one antenna. The radio is designed and manufactured by SilverSat specifically for this mission. The antenna is manufactured by EnduroSat, model UHF Type III. The ground station is installed at the Goddard Amateur Radio Club. The ground station radio is also manufactured by SilverSat and is a copy of the satellite's radio with outboard amplifiers and filtering. In conformance with § 5.107 Transmitter control requirements, all transmissions (data and beacon) from the satellite can be terminated by ground command.

Electrical Power Subsystem (EPS): The EPS consists of the EnduroSat EPS 1 module and five EnduroSat solar panels. The EPS 1 module contains two Lithium-Polymer batteries, maximum power point tracking circuitry for each axis of the satellite, and switchable 5V and 3.3V regulators providing power to the bus. The EPS contains battery heaters which are internally controlled, and will provide heat when the batteries are between 0 deg C and 4 deg C. The batteries are Varta 1/LPP503759 8HH cells. Three safety-inhibit roller switches are in series with the batteries. The solar panels are EnduroSat model 1U and each contain 2 Azur Space triple-junction cells. The Avionics board is powered from the raw battery voltage and controls the operation of the EPS.

Attitude Control Subsystem (ADS): The ADS consists of permanent magnets aligned with the Z axis of the spacecraft, and hysteresis material to dampen tumble. The magnets are 11 Standex Meder - Alnico500 rods, 2.5 mm diameter by 12.7 mm long, glued to the inside of the frame. The hysteresis material is 8 strips of 0.152mm thick Co-NETIC material, each strip measuring approximately 6mm by 25mm. These strips are glued to the inside of the +Z closeout panel, symmetric about the camera opening.

Structure Subsystem: The structure is an EnduroSat 1U frame with an additional aluminum panel for the +Z surface. The frame is 6082 aluminum with a hard anodized finish. The +Z closeout panel is 6061-T6 aluminum with a hard anodized finish.

Payload Subsystem: The Payload subsystem is responsible for taking pictures and sending those pictures to the ground, either as an SSDV stream or a tweet to X (formerly Twitter). The subsystem consists of a single board that contains a Raspberry Pi Zero and a 4D Systems UCamIII camera. The Raspberry Pi Zero is responsible for controlling the camera to take pictures, storing the pictures, and generating the data stream for the downlink and sending it to the radio. In 'Tweet from space' mode, the Raspberry Pi also implements the TCP/IP stack. The camera is mounted to the bottom of the board and protrudes through a hole in the Avionics board. The Payload is powered only when needed, as controlled by the Avionics board.