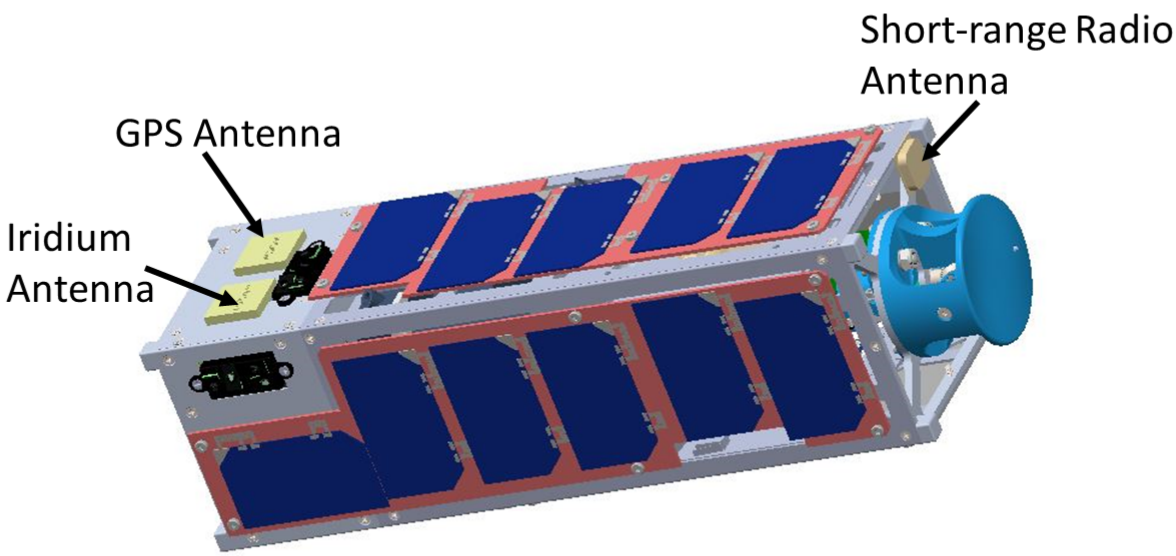
PAN A and B Satellite Mission Technical Description

The overall goal of the PAN A and B mission is to demonstrate a novel autonomous navigation technology developed by Cornell University. With this low-cost autonomous navigation solution for CubeSats, the PAN mission hopes to increase access to space and reduce the risk, expense and complexity associated with autonomous space systems.

The satellites will be launched aboard a Virgin Orbit LauncherOne vehicle, from Kennedy Space Center in May 2019. They will be inserted into an orbit at 500 km apogee and perigee, on an inclination from the equator of 45 degrees. Transmission will begin 45 minutes after deployment from the launch vehicle, and cease no more than four months later. Atmospheric friction will slow the satellite and reduce the altitude of the orbit, until de-orbiting occurs 14.6 years after launch. See the Orbital Debris Assessment Report for details.

PAN A and B are two identical 3U+ CubeSats, each with the dimensions of 3 stacked 10 cm X 10 cm X 10 cm CubeSat modules with a 4.5 cm extension (giving an overall dimension for each satellite of 10 cm X 10 cm X 37.65 cm.) The total mass is approximately 4.6 kg per satellite.

Figure 1 PAN Spacecraft



The satellites contain the following systems: Attitude Determination, Control and Navigation, Command and Data Handling, Communications, Electrical Power, Structure and Propulsion.

Attitude Determination, Control and Navigation Subsystem (ADCNS): The ADCNS uses three reaction wheels for angular momentum storage and three magnetic torque rods for momentum dumping, and provides attitude control in three axes. The system determines spacecraft attitude using five phototransistor-based sun sensors, a gyro and GPS data from the spacecraft's SwiftNav Piksi GPS modem.

PAN A and B Satellite Mission Technical Description

Command and Data Handling (CDH) Subsystem: The spacecraft uses Teensy 3.5 with Arduino IDE as the primary flight controller, and a second Teensy 3.5 controls the ADCNS. The two controllers keep the computationally expensive ADCNS code separate from other spacecraft operations and health monitoring, and this configuration also provides some redundancy in the case of one controller's failure.

Communications Subsystem (COMMS): The PAN A and B units each will communicate with mission operations via the Iridium constellation, using a Quake QLOCATE transceiver of a similar type to the Quake Q4000 and Q2000 which have flown on previous CubeSat missions such as TechEdSat. Each satellite also uses a SwiftNav Piksi GPS receiver and low-power mRobotics SiK transceiver, operating in the range of 915 MHz, allowing the two PAN units to share GPS data during proximity operations.

Electrical Power Subsystem (EPS): The PAN A and B units each use a commercially available GOMSpace CubeSat EPS with flight heritage and qualification, which includes a 2600mAhr Lithium ion battery, a microprocessor and associated hardware and software for battery charging and protection. The solar arrays that charge the battery provide 10W of electrical power on average. They use commercially available SolAero photovoltaic cells with flight heritage and qualification.

Structure Subsystem: The structure is custom-machined set of four walls fabricated from 7075 Aluminum.

Propulsion Subsystem: The PAN A and B units each use a cold-gas propulsion system to maneuver relative to one another. The propulsion system contains 164 grams of R-236fa, a commercially available refrigerant used in automotive applications with flight heritage on previous CubeSat propulsion systems such as UT Austin's Bevo-2 spacecraft. The propulsion system tanks and manifold are made of Accura Bluestone, a high-temperature, high-strength plastic. The system is manufactured by 3D Systems using stereolithography, an additive manufacturing process. Accura Bluestone parts from 3D Systems have been flown by UT Austin and the Aerospace Corporation.