Slingshot-1 FCC Mission Statement

The Slingshot-1 program consists of a single 12U nanosatellite that will host many individual experiments including 1) one GPS 5 GHz transmitter; 2) one SDR S-band transceiver; 3) one satellite traffic management transceiver; 4) one hydrogen peroxide propulsion unit; 5) one Gbps laser transmitter; 6) two research star tracker cameras; 7) one cloud cover camera; and 8) two vehicle-focused cameras.

The Slingshot-1 satellite has been developed by The Aerospace Corporation (Aerospace) for our purpose of conducting experiments in space per our charter as a private, non-profit corporation operating a Federally Funded Research and Development Center in support of the US Air Force (contract number FA8802-19-C-0001).

The Slingshot-1 satellite weighs approximately 19.2 kg and is 37.4 x 24 x 22 centimeters in dimension. It will be launched on the STP S28-B mission's VOX Space LauncherOne rocket with an estimated launch date of October 2021. The orbit will be circular at 500 km altitude with an inclination of 45°.

The Slingshot-1 satellite has two star trackers supporting the bus operation and five imagers supporting payloads. The waiver we have received from NOAA specifies that we are not required to obtain a NOAA license nor even notify NOAA regarding the use of cameras on satellites flown in our capacity as a private, non-profit FFRDC for the US Air Force, which applies in this case.

The Slingshot-1 spacecraft has a hydrogen peroxide (H_2O_2) propulsion system. The thruster is used only intermittently and is not required for any other purpose than to characterize its performance. The propulsion system contains 20 grams of H_2O_2 and can produce a theoretical maximum of 3 meter per second delta velocity on Slingshot-1. The pressure inside of the propulsion system will never exceed 75 psi. Any excess oxygen pressure due to any decomposition of H_2O_2 during storage and prior to operation is expelled through 2 parallel relief valves set to 75 psi. All valves, covers and sensor ports have double o-ring seals and are therefore single fault tolerant. All seals and relief valve function have been verified as part of an acceptance test program on the flight hardware. Prior to use in space, the propulsion system will activate a dedicated heater and heat the H_2O_2 propellant to a maximum of 80 deg Celsius before opening the valves to expel the H_2O_2 vapor through the single catalyst bed where the H_2O_2 will decompose into water vapor and oxygen and then proceed out a nozzle. The maximum pressure of H_2O_2 at 80 deg Celsius is less than 10 psi.

The Slingshot-1 has a 1 Gbps laser transmitter. It is similar in power and wavelength to the laser transmitter flown on AeroCube 7 (OCSD), but it has improved packaging and a higher baud rate. The primary optical ground station is at The Aerospace Corporation in El Segundo, CA. Additional optical ground stations in geographically diverse locations are being developed. Aerospace will coordinate with the Laser Clearing House prior to each operation of the optical transmitter.

The Slingshot-1 satellite has four transmitters.

1. The BCT SDR is the TT&C radio for Slingshot-1. It is built by Blue Canyon Technologies. It is configured to operate in the Unified S-band at 2250 MHz for downlink and 2080 MHz for uplink with up to 3.23 MHz of necessary bandwidth (see "**BCT SDR bandwidth**" exhibit). It has 33 dBm output power that feeds via a diplexer a pair of patch antennas each with 6.8 dBi peak gain

and located on opposite sides of the vehicle. The ground segment for this radio will be provided by Kongsberg Satellite Services.

2. The ASDR2 radio is built by The Aerospace Corporation based on a GOMspace SDR TR600. It is configured to operate in the Unified S-band at 2280 MHz for downlink and 2055 MHz for uplink with up to 4.91 MHz of necessary bandwidth (see "**ASDR2 bandwidth**" exhibit). It has 33 dBm output power feeding a single patch antenna with 7.9 dBi peak gain. A ground antenna in El Segundo, CA will receive the signal. Additional ground sites may be provided by Kongsberg Satellite Services.
3. The GPS SDR transmitter is built by The Aerospace Corporation based on a GOMspace SDR TR600. It is configured to operate 5020 MHz (C-band) with up to 16.2 MHz of necessary bandwidth (see "**GPS SDR bandwidth**" exhibit). It has 39 dBm output power feeding a single patch antenna with 7.8 dBi peak gain. A ground antenna in El Segundo, CA will receive the signal.
4. The AdvRadio is built by The Aerospace Corporation around a Texas Instruments CC1101 transceiver chip. It operates at a fixed 914.7 MHz frequency (see "**AdvRadio bandwidth**" Exhibit) and outputs 1.3 W. The radio attaches to an omnidirectional patch antenna on the satellite body with a 1.75 dBi peak gain.

When Slingshot-1 is ejected, it will power on with the TT&C radio in receive mode. A stored event check/macro will initiate a command to start radio downlink state of health telemetry when reaching a specific position within the orbit (optimal position for start of pass over ground stations). This downlink will occur for a set duration (length of typical pass at specific orbital altitude). This mode of operation will continue until an uplink command is sent to move into nominal operations. Uplinks are performed by initially transmitting a BPSK modulated, randomized idle pattern at the receiver's center frequency from the ground (such as 1ACFFC1D) for a specified time period to achieve lock with the spacecraft receiver. Once positive lock telemetry has been obtained, then commands, table uploads, etc. are uplinked to the spacecraft. If multiple commands are to be sent over the pass, the BPSK modulated randomized idle pattern is maintained to keep the spacecraft receiver "locked" on the uplink signal between commands.

The Blinker payload will also be powered-on automatically immediately after Slingshot-1 is ejected. This payload is intended to operate independently of the spacecraft. It receives GPS fixes periodically in order to determine the orbit of the spacecraft. The ADVradio is dedicated to the Blinker payload. It will be in receive mode only and will not transmit unless asked to do so by a ground station. As the satellite flies over a ground station, the station will continuously beacon towards the satellite. When the satellite radio hears the beacon, along with the proper serial number code, it will respond and a link will be established. At that point, the ground station will ask the satellite for the stored GPS fixes and for Blinker health information. The satellite will respond by downlinking the requested information. When the link is lost due to the satellite passing out of view and the satellite was transmitting, the satellite will try up to 3 seconds to complete the last packet transmitted. The satellite will then revert to a passive receive mode and wait for the next beacon from a ground station.

The other payloads on Slingshot-1, including the GPS SDR and the ASDR2 as well as every other payload listed will not operate automatically. They will require explicit uploaded commands to turn them on and operate them.

DAS 3.1.0 predicts an orbital lifetime of less than 2 years (area-to-mass ratio of 0.0078 m^2/kg) and a spacecraft probability of collision with space objects larger than 15 cm in diameter during the orbital lifetime of the spacecraft of less than 0.000000, which is below the 0.001 threshold required (see "**Slingshot1 DAS310 Output**" exhibit). DAS 3.1.0 analysis predicts that six objects from Slingshot-1 will reach the ground after reentry: 1) three 316-stainless steel reaction wheels, 2) one aluminum IMU housing, and 3) two graphite-epoxy solar panel substrates. Their impact kinetic energies are 214, 2 and 38 Joules, respectively. Items 1 and 3 exceed the 15-J casualty-hazard threshold and were further analyzed with a higher fidelity analysis tool at The Aerospace Corporation (see "**AHaB Reentry Analysis**" exhibit). AhaB predicts that of the three items listed in the DAS analysis, only item 3 will survive with a predicted kinetic energy of 1.4 J.

This license is being requested under 47 CFR Part 5.3 (c) for "experiments under contractual agreement with the United States Government." The experimental radio service as requested is defined under 47 CFR Part 5.5 as "for purposes of providing essential communications for research projects that could not be conducted without the benefit of such communications." Aerospace will be the sole operator of the satellites and all experiments on board.