

From: James VanLandingham

To: Leann Nguyen

Date: January 06, 2015

Subject: FCC File# 0892-EX-PL-2014

Message:

Response to email questions from Leann Nguyen to James W VanLandingham dated 01/06/2015

Applicant: James W VanLandingham
File Number: 0892-EX-PL-2014
Correspondence Reference Number: 26365
Date of Original Email: 01/06/2015

NOTE: Original questions are indicated by >> .

>>A purpose of experiment and a description of project.

The project will provide increased access to space science for commercial companies, educational groups, amateurs and "citizen scientists" with a standardized femto-satellite and streamlined permit procedure, at a significant cost savings to the end user.

ThumbSat will provide the required logistics and standardized hardware (the "bus") that can be tailored to meet the customer's needs and get the customer's experiment into space as quickly as possible utilizing a broad range of launch platforms that are currently available and by taking advantage of a standard configuration of technically identical satellites, covered under a single blanket permit.

Utilizing femto sized satellites of less than 100 grams mass and less than 50mm in any axis, and by booking flights on as many launch vehicles as possible, ThumbSat will be able to relieve the scientist/student of the burdens of paperwork, licensing, insurance and making contacts with the launch providers.

The scientist/student will only have to focus on the experiment that they wish to perform, and ThumbSat will handle the launch as a turn-key system.

Similar to the way the iPhone spawned the creation of tens of thousands of useful and beneficial applications that all utilize identical hardware, or the Raspberry Pi microcomputer that has been used in thousands of extremely low cost applications never dreamed of by the original designers, the customer's ideas will adapt to the existing hardware and the types of experiments that can be performed will be limited only by the imagination of the user community.

After discussing the project with Steve Duall in late October 2014, via phone and email, Steve recommended that the project first obtain an Experimental License in order to perform one or two actual development flights and demonstrate the technology, before possibly moving on to a commercial application and license where a blanket permit will be issued for a multi year period covering several hundred or thousand technically identical satellites. As an example only, ThumbSat might be flown under a commercial permit similar to the one issued to Planet Labs, IBFS file number SAT-MOD-20140912-00100.

Additionally, it is requested that a similar blanket permit be considered/issued under the OET Experimental Licensing Branch, due to the scientific and ongoing experimental nature of the ThumbSat

project. Realistically, due to the simplified application process and lower filing fees, this permit could be issued for a much shorter time frame, (2 years instead of 25), with streamlined renewal after periodic review and reporting. Utilizing a relatively frequent review and extension approval process under the experimental spectrum, is the preferred long term solution for ThumbSat and its operators.

>> If this experiment is used for testing Cube Sat, please submit the following information.

None of the satellites under discussion are CubeSats. The satellites that will be flown are considerably smaller. As many as 32 ThumbSats can fit in the volume of a single CubeSat. Understanding that ThumbSat is not a CubeSat, I have tried to address the questions from the email as they relate to ThumbSat.

>> ODAR Report

A final ODAR Report will be completed and submitted, however as a summary: No debris released in normal operations; no credible scenario for breakups; the collision probability with other objects is compliant with NASA standards; and the estimated nominal decay lifetime due to atmospheric drag is less than 45 days following operations.

>> FCC also needs a NOAA determination and approval for any operation of cameras aboard the cubesats.

It has not been determined that cameras will be flown on the technology demonstration flights, however, a NOAA determination will be requested.

>> Please provide a tentative schedule of cubesat construction, launch integration dates and proposed launch dates and providers. Include the exact number of cubesats that you expect to launch.

50 flight model ThumbSats are expected to be manufactured in May, 2015, with integration and launch anticipated for Q3 and Q4, 2015. No particular launch vehicle or location has been chosen at this time, due to the uncertainty of permitting, and a particular orbit is not required for the demonstration flights. Launches of opportunity will be utilized.

>> Is the satellite geostationary or non-geostationary?

The ThumbSat swarms will be Non-geostationary.

>> If satellite is non-geostationary, please submit inclination angle, apogee (km)/perigee (km), orbit period (hours), fractions of hours in decimal and number of satellites in the system.

“...inclination angle, apogee (km)/perigee (km), orbit period (hours), fractions of hours in decimal and number of satellites in the system.” will all depend on the launch chosen for the demonstration flight and is not critical for our purposes. Nor will this data generally be known for future launches. ThumbSat will operate on a basis of launch availability globally, and will piggy-back on existing launches. Orbits will vary drastically and will essentially not be a major consideration for any particular mission.

Our aim for the demonstration flight is to utilize the NanoRacks platform from International Space Station (ISS) to perform orbital insertion. Initial altitude of the ThumbSat swarm depends on ISS altitude at time of ejection. The full range of 410 km (“high insertion case”) to 380 km (“low insertion case”) is possible.

>> Description of the satellite and how it will operate.

The ThumbSat is designed as a femto-satellite with on-board sensors and radio transmitter. Maximum mass will be 100 grams, with a maximum dimension in any axis of 50mm. The functional hardware will be identical across all satellites, with only software and minor payload changes from mission to mission. For

the technology demonstration flights being requested under this permit, two launches of 25 satellites each are being planned for Q3 and Q4 of 2015, in order to flight test the hardware, and the ability of the ground stations to track the swarm and gather the transmitted data.

ThumbSat has an on-board battery capable of powering the space station for approximately 96 hours. There are no solar cells, or other means to increase operating lifespan. As a result, the satellite will cease operation in less than a week and de-orbit in 30 - 45 days.

>> An analysis transmitting between satellites to satellite.

There will be no transmissions between one satellite in the swarm and the next. Only transmission between space to ground.

>> An analysis transmitting between satellites to ground stations.

The space station will transmit its data in programmed bursts for specific periods of time, depending on the data to be transmitted, using standard, off the shelf hardware: Radiometrix LMT2 transmitter, on an as yet undetermined frequency, between 400 and 410Mhz. (Frequency will be determined by availability and FCC recommendation.) Transmit power will be less than 100milliwatts.

9) Information of satellite transmitter antenna including gain, beamwidth, azimuthal range.

ThumbSat is currently designed to utilize a single, omni-directional antenna with a gain of 1.0dBiC to transmit an Effective Isotropic Radiated Power (EIRP) level of -10.0dBW. This results in a slant range of approximately 1,400 km based on an orbital height of 400km.

>> Information of earth station receiver antenna including gain, beamwidth, azimuthal range, elevation above mean sea level (m), minimum angle of elevation and antenna height above terrain (m).

Earth Stations will be operated by volunteer groups around the globe as part of educational partnerships between ThumbSat and various high schools and universities in an effort to increase student interest in Science, Technology, Engineering and Mathematics (STEM) concepts, as well as Physics, Radio Technology, understanding the Space Environment etc etc. a brief sample of existing volunteer stations that are already operating are:

- • Tereora College, Cook Islands
- • Markham College, Peru
- • Admiral Arthur Radford High School, United States, Hawaii
- • Instituto Diocesano de Formação, Sao Tome and Principe
- • Christmas Island District High School, Christmas Island
- • Academia Cotopaxi, Ecuador

As well as various individuals in the U.K., Hong Kong, Micronesia, Tanzania and other locations.

The ground station consists of primarily a Software Define Radio run on a laptop computer, hand-held, high gain YAGI style antennas and orbital tracking software. Students track the ThumbSat swarm and gather the transmitted data, which is sent to a central ThumbSat server for collection and data reconstruction. Due to limitations of severe weather in most island and equatorial nations, no permanent infrastructure is installed.

>> Stop Buzzer information including name and telephone number of person who will terminate the system if having interference occurs.

The operational period of the ThumbSat swarm is extremely brief, with only a power supply limit of approximately 24 hours' worth of transmitting time. With a transmitted power less than 100milliwatts, and such a short operational period, it is expected that no possibility for interference exists. Additionally, it is expected that the satellite will have ceased all operation in the length of time an interference complaint could be filed.

Regardless, the primary point of contact for the ThumbSat project and all communication with the FCC is James W. VanLandingham, W4VNO, 904-392-1938, 153 Whisper Ridge Drive, St Augustine, FL, 32092.