Exhibit A - Narrative Statement

Introduction

Swarm Technologies Inc ("Swarm") is a California-based corporation seeking to deploy twelve communications satellites to evaluate duplex, narrowband Internet of Things (IoT) connectivity solutions for remote and mobile sensors. Each of the proposed satellites has a ¼U form factor.[1]

The satellites will use VHF band frequencies for communications. There will also be an experimental deployment of three ground stations in the United States for communications with the space units. The VHF frequencies proposed in this application, more specifically in the 137-138 MHz and 148-150.05 MHz bands, are allocated on a primary basis for Mobile Satellite Service (MSS) communications for non-Federal, non-voice, non-geostationary orbit (NGSO) systems, and are capable [redacted]

Swarm requests experimental authority to [redacted]

Experimental Program Description

The proposed architecture is comprised of both space and ground units [redacted]

[1] The basic unit for the cubesat form factor ("1U") is a 10x10x10 cm cube weighing less than 1.33 kg. Swarm's ¼U satellites are approximately 10x10x2.5 cm, and fit within standard CubeSat deployers.

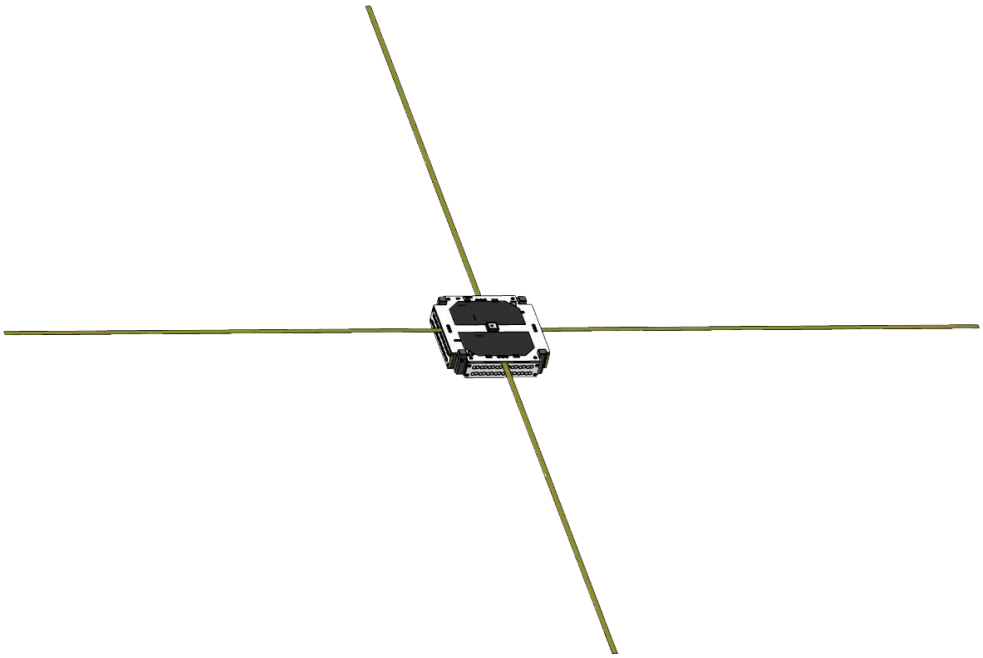

Figure 1. Image of a single satellite.

The satellite contains a battery [redacted] There are solar panels that provide recharge, maintaining a positive orbit average net power and allowing the satellite to potentially remain operational for up to 10 years (longer than the expected orbital lifetime). [redacted] Communication between space and ground elements uses VHF frequencies.

Experimental Program Goals

The goals of the proposed experimental deployment differ from and expand upon those provided in Swarm's previous filings for experimental authorization (0976-EX-ST-2018, granted October 1, 2018 and 0943-EX-CN-2018, granted April 4, 2019). Most importantly, the proposed experimental program in this application will be an opportunity for Swarm to test the final satellite design and form factor intended for Swarm's proposed commercial constellation.[2]

The experimental program is designed to meet the following objectives and validations:

[redacted]

[2] Swarm filed a Part 25 application for a constellation of 150 satellites on December 21, 2018 (see SAT-LOA-20181221-00094).

[redacted]

General Description of the Overall System and Operations

The Swarm satellite network consists of twelve data relay satellites and three ground stations [redacted]

The system architecture consists of ground stations [redacted]

[redacted] All uplink and downlink transmissions will be one-way.

Any transmission can be immediately terminated by ground command if interference is detected or reported.

Public Interest Consideration

The commission's grant of this application will serve the public interest by allowing Swarm to demonstrate the above described [redacted]

Launch, Orbital Parameters, and Lifetime

The experimental deployment space launch is planned for the Rocket Lab Electron launch vehicle currently scheduled for December 2019 into Low Earth Orbit (LEO) at approximately 505 km altitude. The Swarm satellites do not employ propulsion, and with their low mass, the orbits will naturally decay and the satellites will re-enter the atmosphere within approximately 3.7 years or less (nominal scenario, see ODAR in Exhibit B for more details) and completely burn up before reaching the ground. Table 1 details the anticipated orbit parameters.

Table 1. Anticipated orbit for Swarm satellites.

Orbital Parameters	Values	Accuracy
Inclination Angle (deg.)	97.4 (SSO)	+/- 1
Apogee (km)	505	+/- 50
Perigee (km)	505	+/- 50
Semi-major Axis (km)	505	+/- 50

Orbital Debris and Assessment Report (ODAR) and Radar Tracking

Exhibit B attached to this application describes fully the orbital debris and assessment report requirements pursuant to 47 C.F.R. § 5.64.

Satellite Trackability

Each Swarm satellite proposed in this deployment incorporates 4 passive radar retroreflectors in order to increase the radar cross section of the satellite to improve trackability. A detailed analysis of the trackability of Swarm's ¼U satellites is attached as a separate exhibit to this application (see Exhibit D: Trackability Analysis). As shown in the attached Exhibit D, Swarm's ¼U satellites can be persistently detected and persistently tracked with comparable precision to a standard 1U satellite by normal means through the Space Surveillance Network (SSN).

Swarm's ¼U satellites can also be tracked by normal means through the LeoLabs radar network.[3] The radar cross section is comparable in size or larger for Swarm's ¼U satellites than for comparable ½U and 1U satellites. Swarm's ¼U satellites are more detectable than the ½U Aerospace Corporation satellites (NORAD IDs 40045 and 40046) and 1U STEP CUBE LAB (NORAD ID 43138) and 1U FOX-1D (NORAD ID 43137) satellites (see attached Exhibit E: LeoLabs Report).

Swarm is in contact with the Combined Space Operations Center (CSpOC) to receive conjunction threat reports for its 4 experimental ¼U satellites and 5 experimental 1U satellites currently on orbit, and Swarm will continue to remain in contact with CSpOC to coordinate conjunction events with the satellites proposed in this application. Furthermore, Swarm has contracted with LeoLabs, a private company specializing in the tracking of satellites and orbital debris, to provide a second source of tracking and potential collision data to supplement the data provided by the Space Surveillance Network (SSN). LeoLabs will provide tracking data for the Swarm satellites proposed in this application. Swarm will also actively track its satellites with onboard GPS, and the GPS data will be transmitted to the Swarm ground stations on regular

[3] LeoLabs is a private company providing tracking and mapping services for satellites and orbital debris. LeoLabs conducted radar measurements and analyzed the trackability and detectability of Swarm's ¼U satellites currently on orbit. A report from LeoLabs regarding the trackability and detectability of the satellites is attached as a separate exhibit. See Exhibit E: LeoLabs Report.

intervals. Swarm will provide both active and passive tracking data to other satellite operators upon request.

Non-Interference Criterion

Pursuant to 47 C.F.R. § 5.84 and 5.85, it is understood that a grant of authority for this experimental program will be on a non-exclusive and non-interference basis to both Federal and non-Federal authorized users of the VHF spectrum proposed in this application. Operations under the experimental program will be conducted only at the three coordinated ground station sites. Exhibit C attached to this application describes fully the electromagnetic compatibility of the Swarm system with other users and services in the VHF frequencies proposed in this application, more specifically in the 137-138 and 148-150.05 MHz bands.

Power Flux Density Calculation at Earth's Surface

In compliance with Section 25.142 of the Commission's rules, in the 137-138 MHz band the power flux density (PFD) at the Earth's surface produced by a Swarm satellite will not exceed -133 dBW/m² in any 4 kHz band at any angle of arrival (see Exhibit C: Interference Analysis).

The out of band emissions are minimized by digital modulation techniques and filtering with at least 20 dB spectral rolloff at 120% of signal bandwidth in any 4 kHz band, 40 dB at 200% bandwidth, 55 dB at 300% bandwidth, and more than 60 dB beyond 4 times the bandwidth. Frequencies in the 137.880-138.000 MHz band (space-to-ground) and the 148.300-148.420 MHz band (ground-to-space) were chosen to remain within the band allocated to NGSO MSS, minimizing potential for interference into adjacent services, including allowance for Doppler shift and frequency tolerance.

Radio System Technical Characteristics

The link parameters for ground-to-space and space-to-ground communications are further characterized in the link budget provided in Table 2.

Table 2. Space and ground link budget.

	ground to satellite		satellite to ground		
Item	**Nominal**	**Worst-Case**	**Nominal**	**Worst-Case**	**Units**
Satellite Orbital Altitude	**505**	**505**	**505**	**505**	km
Earth Radius	6371	6371	6371	6371	km
Frequency	0.149	0.149	0.138	0.138	GHz
Elevation Angle to Satellite	50	0	50	0	deg
Satellite Angle from Nadir	36.55	67.90	36.55	67.90	deg
Theta Angle	3.45	22.10	3.45	22.10	deg
Transmitter Power	**1.50**	**1.50**	**0.70**	**0.70**	Watts
Transmitter Power	1.76	1.76	-1.55	-1.55	dBW
Transmitter Line Loss	-1.00	-1.00	-1.00	-1.00	dBW
Peak Transmit Antenna Gain	11.00	11.00	0.00	0.00	dBi
Transmit Antenna Pattern Loss	-3.84	0.00	-1.18	-2.97	dB
Transmit Total Gain	6.16	10.00	-2.18	-3.97	dB
Eq. Isotropic Radiated Power	**7.92**	**11.76**	**-3.73**	**-5.51**	**dBW**
Propagation Path Length	643	2586	643	2586	km
Path Loss	-132.08	-144.17	-131.41	-143.50	dB
Polarization Loss	-3.00	-3.00	-3.00	-3.00	dB
Power @ Receiver Antenna	**-127.16**	**-135.41**	**-138.14**	**-152.02**	**dBW**
Peak Receive Antenna Gain	0.00	0.00	11.00	11.00	dBi
Receive Antenna Line Loss	-1.00	-1.00	-1.00	-1.00	dB
Receive Antenna Pattern Loss	-1.18	-2.97	-4.50	-0.66	dB
Rx Gain with pointing error	-2.18	-3.97	5.50	9.34	dB
Rx Power	**-129.34**	**-139.37**	**-132.64**	**-142.68**	**dBW**
Necessary Bandwidth	20.8	20.8	20.8	20.8	kHz
Assigned Bandwidth per Channel	30.0	30.0	30.0	30.0	kHz
Target Rx Level	-162.80	-162.80	-162.80	-162.80	dBW
Implementation Margin	6	6	6	6	dB
Remaining Margin	**27.46**	**17.43**	**24.16**	**14.12**	**dB**

The satellite antenna is a turnstile antenna consisting of two half-wave dipole antennas aligned at right angles and fed 90 degrees out of phase. This provides an omnidirectional circular polarization pattern that improves communication with linear polarized antennas on the ground over all orientations. For the ground stations, two different types of antennas will be evaluated: 1) a vertically polarized half-wave monopole antenna with a maximum gain of 2 dBi, and 2) a 5-element Yagi antenna with a maximum gain of 11 dBi.[4] Figures 2 through 4 show the space

[4] The ERP value provided in the accompanying Form 442 reflects the highest-gain antenna that will be used with Swarm's ground stations.

and ground antenna patterns and characteristics, applicable for both transmit and receive.

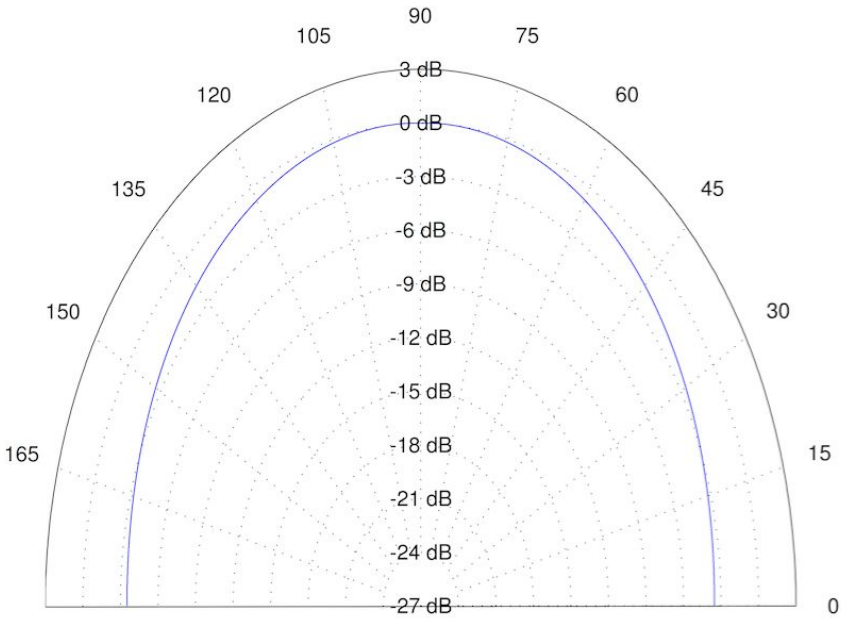

Figure 2. Satellite TX and RX antenna pattern.

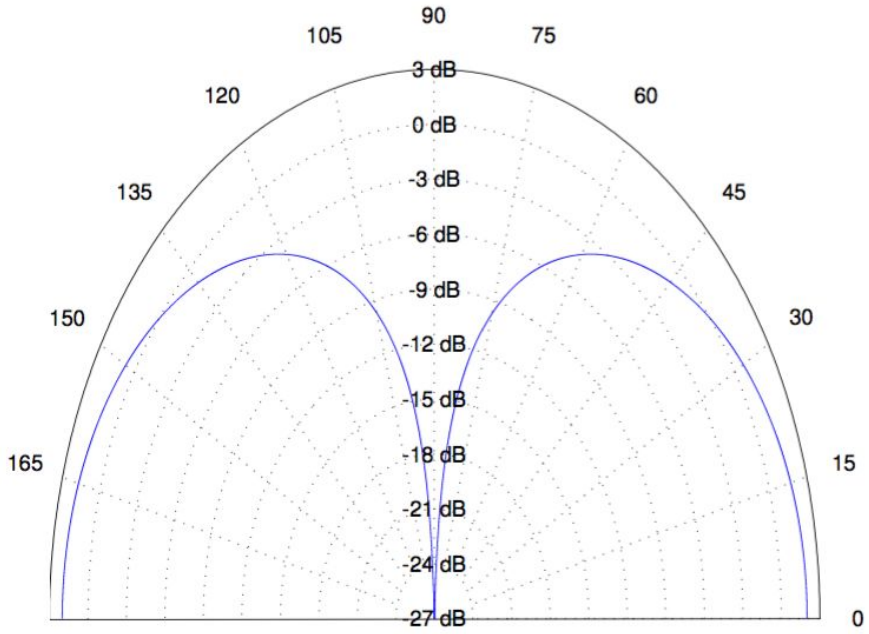

Figure 3. Ground station TX and RX antenna pattern (end-fed vertical monopole antenna).

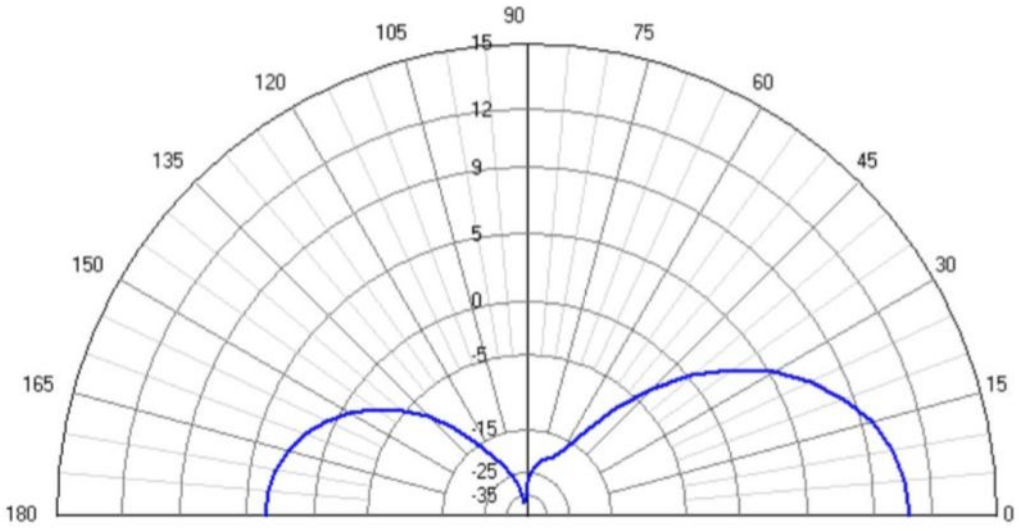

Figure 4. Ground station TX and RX antenna pattern (Yagi antenna).

All satellite to ground station communications initiate upon command and self terminate at the completion of the data transmission. If any deviation from the authorized technical requirements of the transmission is detected, the ground system will mute further transmissions until the deviation is understood and can be corrected.

Swarm requests a waiver of rule 47 C.F.R. § 5.115 related to station identification. More specifically, Swarm requests a waiver of the requirement for periodic station identification in the interest of minimizing transmission durations and activity. Grant of such waiver serves the public interest, as compliance with the station identification requirement unnecessarily adds additional data and modulation changes during transmissions. Grant of such waiver does not adversely affect the spectrum rights of any third party and is consistent with Commission's longstanding commitment to spectral efficiency.

Ground Station Locations

Ground Station 1
845 Madonna Way
Los Altos, CA 94024
lat/long (NAD83): 37.3648, -122.1108, 132 m
Antenna height: 3 meters above ground level
Antenna type: VHF vertical monopole or Yagi antenna

Ground Station 2
5967 McEver Road
Flowery Branch, GA 30542
lat/long (NAD83): 34.1913, -83.9415, 354 m
Antenna height: 3 meters above ground level

Antenna type: VHF vertical monopole or Yagi antenna

Ground Station 3
14963 S. Canyon Pointe Rd.
Draper, UT 84020
lat/long (NAD83): 40.4814, -111.8230, 1796m
Antenna height: 3 meters above ground level
Antenna type: VHF vertical monopole or Yagi antenna

ITU Advance Publication and Cost Recovery

Pursuant to 47 C.F.R. § 25.111 for space systems, it is understood that the commission will submit filings to the ITU on behalf of the applicant pursuant to international obligations for the coordination and registration of space network systems. Swarm will provide the commission the appropriate electronic files for submission to the ITU and hereby provides its commitment to the cost recovery of any such filings to the ITU.