Exhibit B: Swarm ¼U Satellite Trackability and Persistence Analysis

Radar Cross Section Measurements of the SPACEBEEs from SPAWAR

In the summer and fall of 2017, detailed radar measurements were taken at the Space and Naval Warfare (SPAWAR) Systems Center in San Diego under a Cooperative Research and Development Agreement (CRADA) with Swarm Technologies. The Swarm satellites (SPACEBEEs) were designed to accommodate four specially designed radar retro-reflectors developed by SPAWAR. The radar retro-reflectors make the SPACEBEE satellites have a larger radar cross section (RCS) than a 1U satellite on average when integrated over all angles (see Figure 1). Figure 2 shows a SPACEBEE undergoing testing at SPAWAR, and Figure 3 shows the increase in RCS upon incorporation of radar retro-reflectors.

30 October 2017

To whom it may concern,

As part of a Cooperative Research and Development Agreement with SWARM Technologies, Space and Naval Warfare (SPAWAR) Systems Center San Diego developed a RADAR Retro-reflector suitable for a 1/4 U sized Nano-Satellite. The purpose of this development is to improve the ability to detect and track small objects on orbit using terrestrial Space Object Tracking RADAR Systems. RADAR Cross Section (RCS) measurements were taken at the SPAWAR Systems Center San Diego Anechoic Chamber with four ¼ U Retro-reflectors attached to a SWARM Technologies ¼ U satellite. Based on those RCS measurements, the following assessment is made: with the Retro-reflectors attached, the Swarm Technologies ¼ U satellite is equal to a 1 U satellite when the large face of the Swarm satellite is normal to the RADAR. The RCS of the Swarm satellite is slightly less when a 1/4 panel is normal to the RADAR, and is better than a 1 U at all other angles. On average (integrated over all angles), the Swarm satellite with the Retro-reflectors attached has a larger RCS than a 1 U satellite.

T R Albert

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Project Manager and Systems Engineer
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Figure 1. Letter from SPAWAR to Swarm Technologies on the RCS measurements taken at SPAWAR. On average, the SPACEBEE satellites have a larger radar cross section than a 1U satellite.

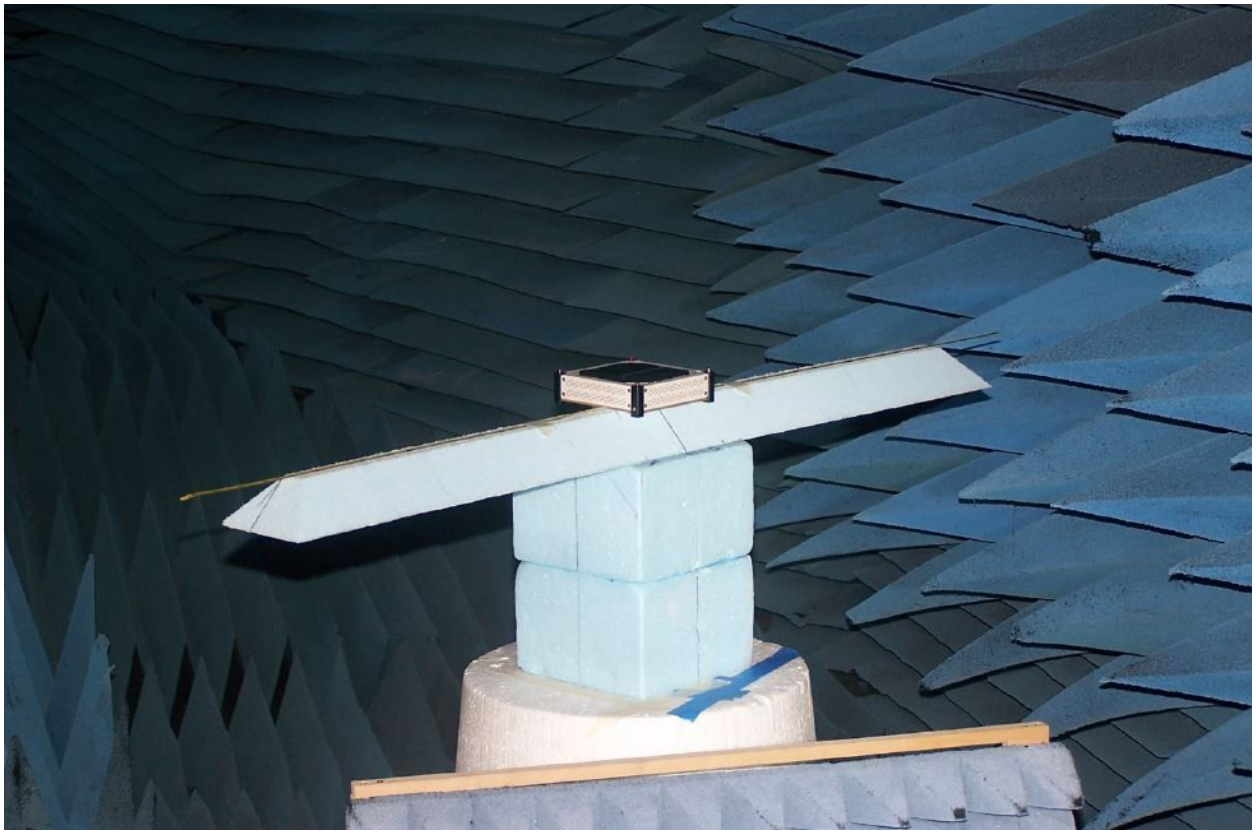

Figure 2. A SPACEBEE undergoing RCS measurements in an anechoic chamber at SPAWAR.

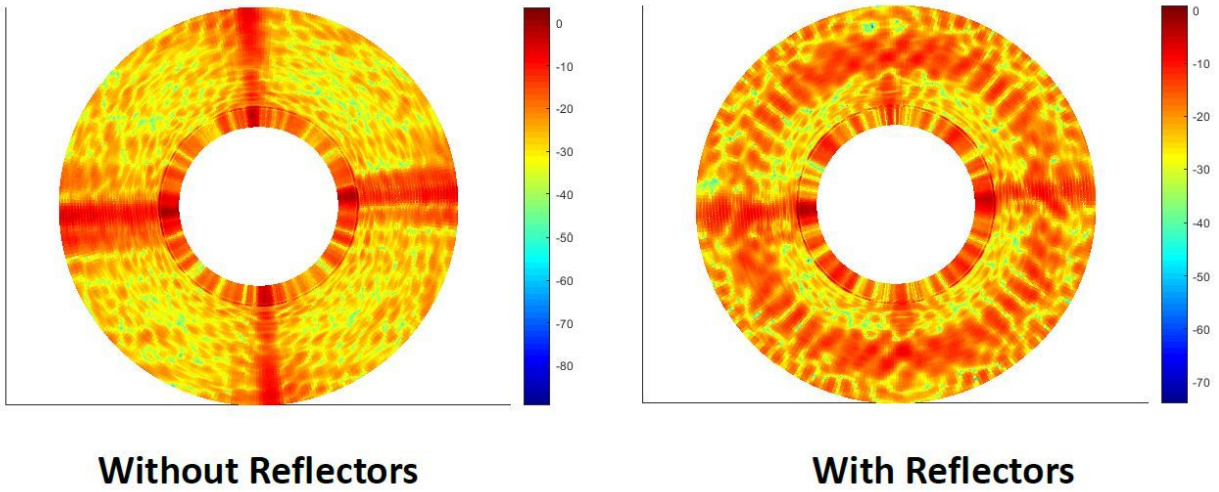

Figure 3. Radar cross section measurements of a SPACEBEE satellite without (left) and with (right) the Radar retro-reflectors. The RCS is larger over all angles with the radar retro-reflectors (right).

SSN Tracking Data

The Space Surveillance Network (SSN) provides tracking data to any satellite operator, updated several times per day. The SSN has been providing reliable and persistent tracking data since the launch of four ¼U (10cm x 10 cm x 2.8 cm) SPACEBEE satellites on January 12, 2018. The SSN provides tracking data in the form of Two Line Elements (TLEs), which define a satellite's orbit. Many RADAR and optical sensors on the ground contribute to the creation of a TLE data product, and the SSN does not provide the raw sensor data used to calculate TLEs.

Figure 4 shows an orbital model from May 2018 of the four SPACEBEE satellites currently on orbit that was generated using TLEs provided by the SSN.

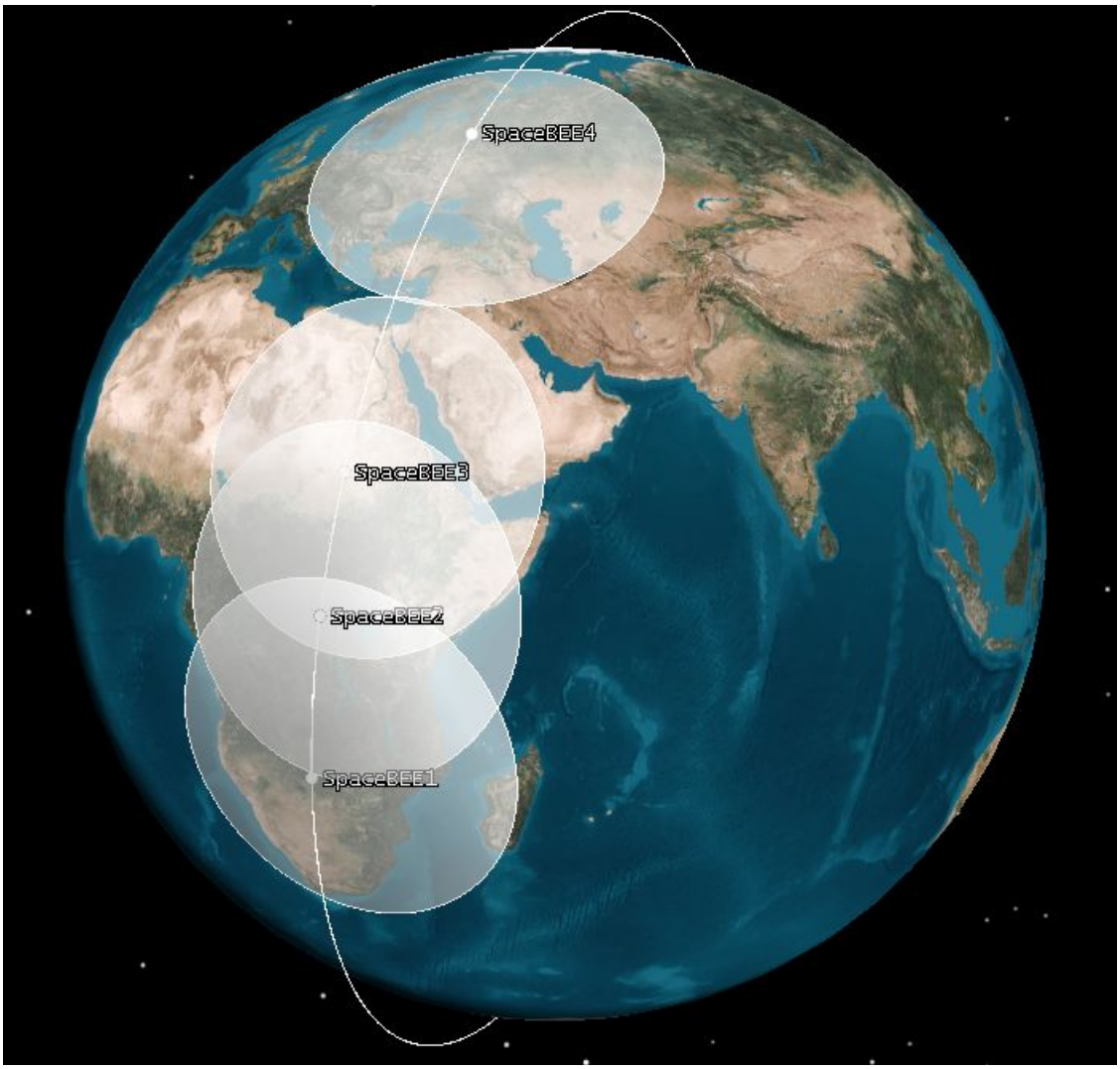

Figure 4: STK orbital model from May 2018, created using the TLEs of the SPACEBEE satellites provided by the SSN.

The number of TLEs from the SSN for the Swarm ¼U satellites was compared to that of two 1U satellites that were deployed into low Earth orbit (LEO) on the same PSLV-C40 launch vehicle as the four Swarm ¼U satellites. The date range used for the TLE comparison is January 12, 2018 to September 12, 2018. The TLEs for the following satellites are compared:

Table 1: Satellites compared to determine the average number of TLEs per day.

Satellite Name	**Size**	**NORAD ID**
SPACEBEE-1	¼U	43142
SPACEBEE-2	¼U	43141
SPACEBEE-3	¼U	43140
SPACEBEE-4	¼U	43139
FOX-1D	1U	43137
STEP CUBE LAB	1U	43138

Examples of TLEs for the six satellites studied are shown in Table 2.

Table 2: Examples of TLEs reported for the satellites studied.

Satellite Name	**Example TLE**
SPACEBEE-1	1 43142U 18004AH 18259.60168188 +.00003499 +00000-0 +14721-3 0 9993 2 43142 097.5272 322.7882 0010477 136.5268 223.6797 15.24022623037632
SPACEBEE-2	1 43141U 18004AG 18259.60963318 +.00003218 +00000-0 +13599-3 0 9991 2 43141 097.5270 322.7734 0010498 136.2689 223.9381 15.23931415037642
SPACEBEE-3	1 43140U 18004AF 18259.48517909 +.00003133 +00000-0 +13279-3 0 9998 2 43140 097.5268 322.6291 0010490 136.5573 223.6492 15.23849747037626
SPACEBEE-4	1 43139U 18004AE 18260.16161168 .00002446 00000-0 10508-3 0 9993 2 43139 97.5262 323.2533 0010600 134.1314 226.0796 15.23613333 37718
FOX-1D	1 43137U 18004AC 18288.74011360 .00001203 00000-0 54230-4 0 9994 2 43137 97.5208 351.7023 0010551 46.1266 314.0840 15.22958409 42055
STEP CUBE LAB	1 43138U 18004AD 18289.42814421 .00002080 00000-0 90624-4 0 9991 2 43138 97.5212 352.4849 0010348 45.1643 315.0432 15.23308803 42176

As shown in Table 3 and Figure 5, the number of TLEs per day reported by the SSN for the SPACEBEEs is comparable to or greater than that of two larger 1U satellites deployed on the same launch. In fact, the number of TLEs issued per day for the ¼U SPACEBEEs compares favorably to that of all CubeSats monitored by the SSN (see Figure 5). As shown in Figure 6, the SPACEBEEs are also persistently trackable: TLEs have been consistently reported for the SPACEBEEs throughout the 9-month period following launch, just as they have been for 1U satellites launched on the same date. The satellites launched as part of the commercial network will have 4 antennas (RHCP turnstile) compared to the 2 antennas (linear dipole) for SPACEBEE-1 to -4. The commercial satellites will have a larger RCS than the SPACEBEE-1 to -4.

Table 3: Comparison of number of TLEs per day reported by the SSN for various CubeSats.

Satellite Name	**Size**	**Average Number of TLEs Issued per Day**
50th percentile (median) for all Celestrak CubeSat entries	N/A	2.08
SPACEBEE-1	¼U	2.30
SPACEBEE-2	¼U	2.15
SPACEBEE-3	¼U	2.20
SPACEBEE-4	¼U	2.24
FOX-1D	1U	2.12
STEP CUBE LAB	1U	2.12

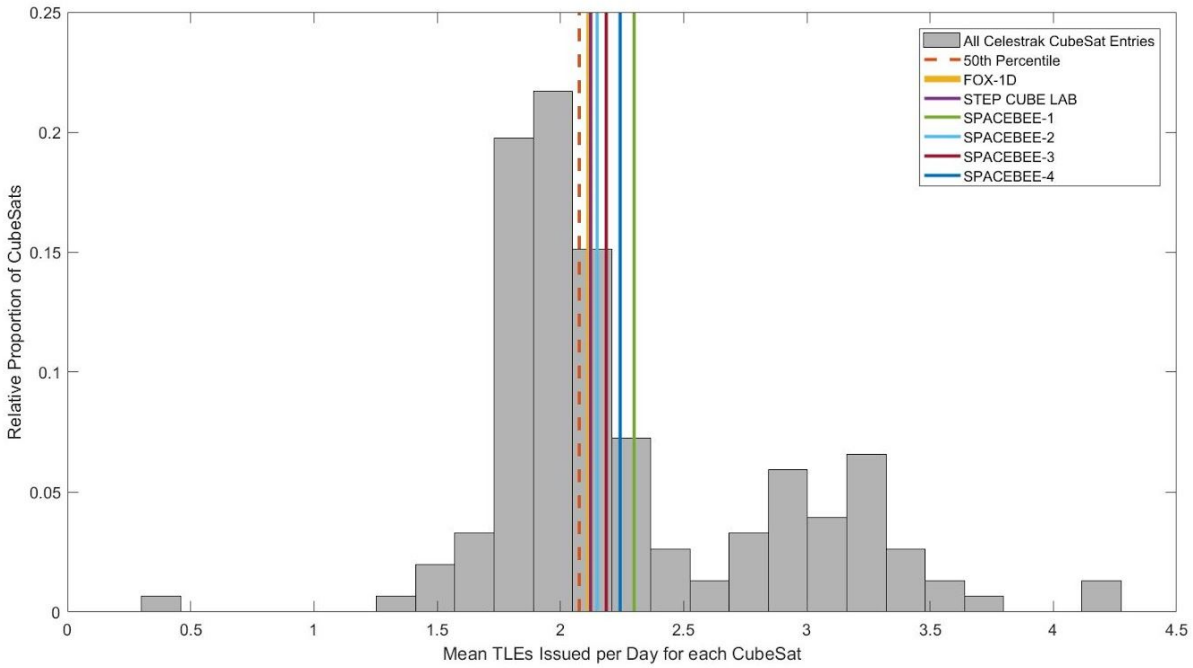

Figure 5: Percentile of TLEs per day provided by the SSN for all CubeSats, including ¼U , ½U, 1U, 2U, 3U, and 6U satellites. SPACEBEE satellites have more TLEs than the 50th percentile of all CubeSats, and more TLEs than two 1U satellites launched at the same time and into the same orbit.

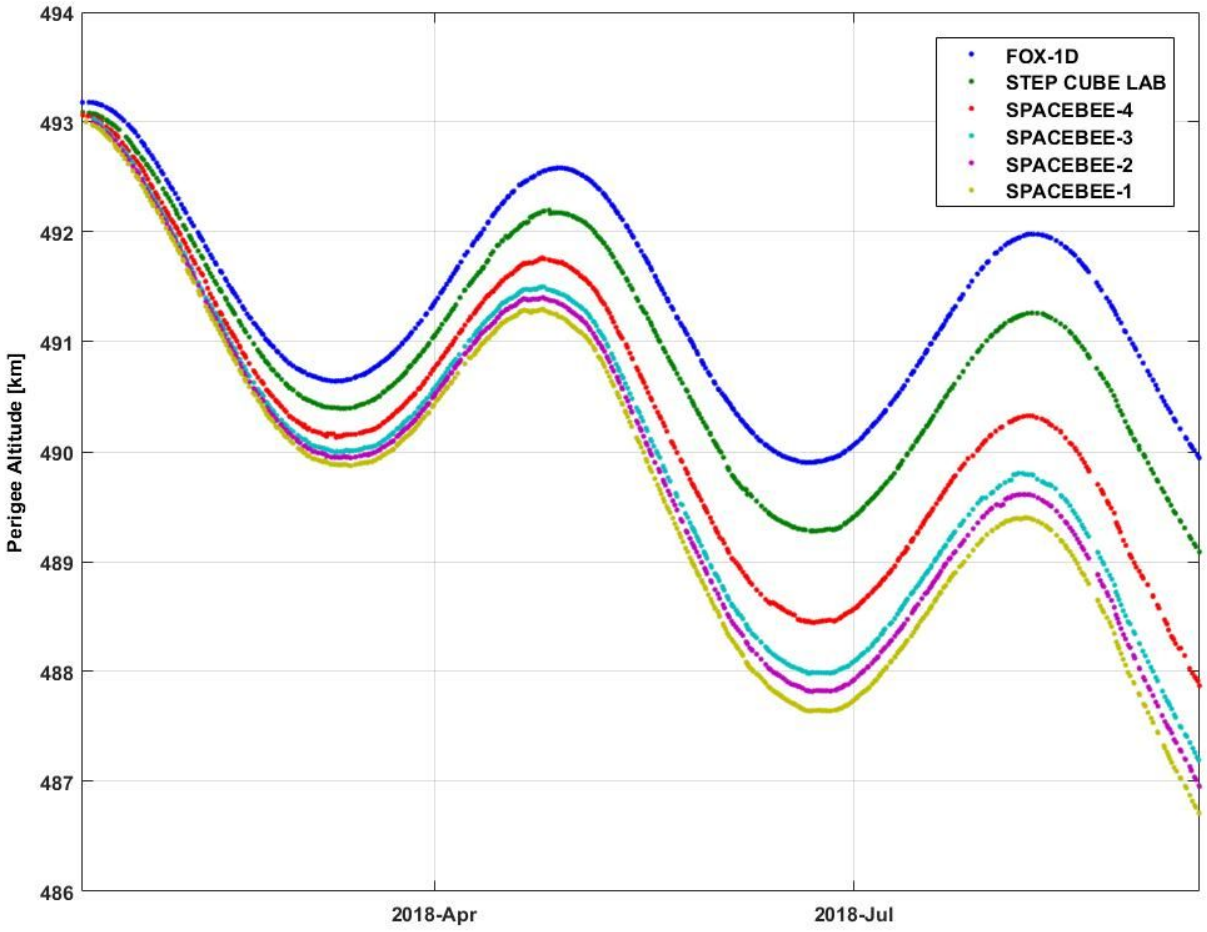

Figure 6: Perigee altitude for the 6 satellites studied from January 12, 2018 to September 12, 2018. All TLE data points are shown for this time period. Each data point is a single TLE. All six satellites have high quality tracking data.

Conclusions

- TLEs for SPACEBEE-1, SPACEBEE-3, SPACEBEE-4 have been generated since launch date and are updated more times per day than the 1U satellites STEP CUBE LAB and FOX-1D.
- TLEs for SPACEBEE-2 are updated the same number of times per day as the 1U satellites STEP CUBE LAB and FOX-1D.
- The Swarm ¼U satellites are detected by the SSN just as well as 1U satellites in comparable orbits.
- The Swarm ¼U satellites are tracked by the SSN with the same or better persistence as 1U satellites in comparable orbits.

Leolabs trackability and detectability of SPACEBEE satellites

Swarm hired LeoLabs to track the SPACEBEE satellites, two ½U Aerospace Corporation satellites, and a number of 1U satellites that are in similar orbits to the Swarm SPACEBEE satellites for a duration of 30 days. The orbital data from the SPACEBEE satellites, the ½U Aerospace Corporation satellites, and the 1U satellites are reported in full in the attached Exhibit C: LeoLabs Report. The orbital data presented in Exhibit C is solely from the LeoLabs private radar facilities, and the data is independent from and not generated from the SSN.

The results of the LeoLabs study indicate:

- The detectability of the SPACEBEE satellites is:
    - Similar to much larger reference spheres, which orbit at higher altitude
    - Higher than 1U satellites (STEP CUBE LAB and FOX-1D) that are in very similar orbits
        - SPACEBEEs are detected 1.1 to 1.2 times per day on average
        - STEP CUBE LAB and FOX-1D are detected 0.8 to 0.9 times per day on average
    - Higher than the 1/2U Aerocube satellites, which are in a higher altitude orbit
        - SPACEBEES are detected 1.1 to 1.2 times per day on average
        - AEROCUBE-6A and AEROCUBE-6B are detected 0.6 times per day on average

- Measured Radar Cross Section (RCS)
    - The radar cross section is larger for the SPACEBEEs than for comparable ½U and 1U satellites on average

- Orbital Solutions
    - The percentage of orbital passes where the SPACEBEEs are detected is the same or higher relative to comparable ½U and 1U satellites
    - The orbital solutions are more accurate or equivalently accurate for the SPACEBEEs relative to comparable ½U and 1U satellites