Exhibit C - Interference Study

Interference and Electromagnetic Compatibility Study

The experimental Swarm satellite network, which includes 4 satellites and 2 US earth stations[1], employs the 137-138 MHz band for space to earth, and 148-149.9 MHz band for earth to space links, consistent with the US and International table of frequency allocations. To demonstrate compliance with an experimental systems obligation to operate on a non-interference basis with other authorized operators in the bands, this report provides a three part electromagnetic compatibility study with the existing authorized users. Specifically, 1) a study of compatibility with terrestrial services, 2) a study of compatibility with other satellite systems, and 3) a study of compatibility with radio astronomy services.

Statement for Terrestrial and Aeronautical Mobile system compatibility

ITU Radio Regulations impose power flux density (PFD) limits that trigger coordination for certain terrestrial (fixed and mobile) and aeronautical mobile systems in the 137-138 MHz band and adjacent 138-143.6 MHz band[2]. In summary the PFD thresholds that trigger coordination are as follows:

- Terrestrial Services: -125 dBW/m^2/4KHz
- Aeronautical Mobile (R): -125 dBW/m^2/4KHz
- Aeronautical Mobile (OR): -140 dBW/m^2/4KHz

Figure 1 shows a plot of the expected PFD at Earth's surface for all angles of arrival over the range of possible operational orbit altitudes. Note that due to the antenna gain pattern, the PFD at Earth's surface diminishes significantly as the satellite elevation increases towards 90 degrees. The gain pattern is optimal for communications at elevations 10 to 60 degrees where the majority of ground access time occurs.

[1] The four satellites for which an authorization is sought will transmit only when within line of sight of two US earth stations, one in Palo Alto CA, and one in Atlanta GA, when commanded by the ground station. No other earth stations will transmit to the four satellites.
[2] ITU RR Appendix 5, Annex 1, article 1.1.1 and 1.1.2

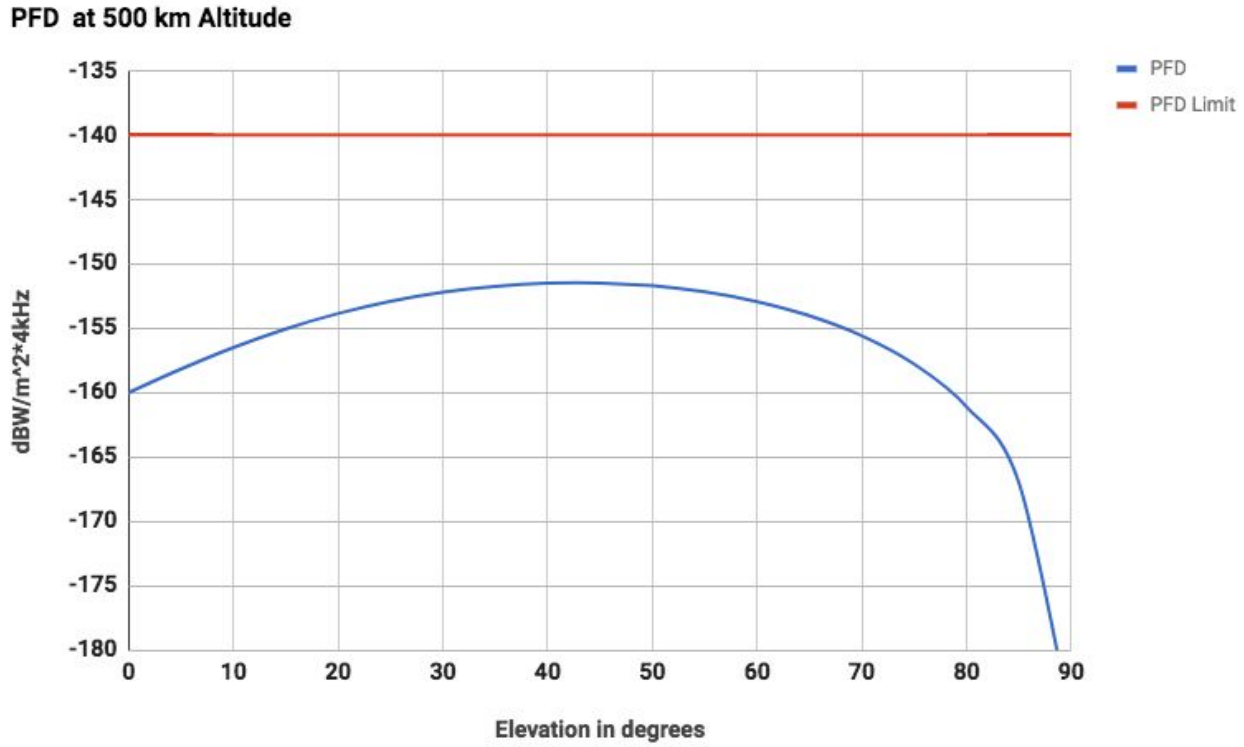

Figure 1. PFD at Earth's surface produced by a space BEE transmission

In summary, the power flux density (PFD) at the Earth's surface produced by the Swarm satellites will not exceed -151.5 dB(W/m^2) in any 4 kHz band at any angle of arrival, which is under the threshold for coordination with both terrestrial services and aeronautical mobile (OR) and therefore does not trigger a coordination requirement.

Statement of Satellite Service system compatibility.

From the ITU Space Network Systems Online (SNS), a list of satellite systems using the 137-138 MHz band and 148-150.05 MHz band was collected and shown in Table 1 and Table 2 respectively below. For each satellite system, the table indicates the administrative jurisdiction, service areas, frequency overlaps, and ultimately a disposition for a coordination requirement. Most satellites have either no frequency overlap with Swarm satellites, have no area coverage overlap, or earth stations in the USA. In addition, a search of the FCC IBFS for the 137-138 MHz band and 148-150.05 MHz band show that only Orbcomm is licensed for a space system using these space services links within the United states. In summary, only Orbcomm Satellites, NOAA N, GOES West, and the METOP satellites require some form of coordination for operations in the USA. Swarm will seek consent from both the NTIA and Orbcomm regarding those systems.

It should be noted that the European METOP satellite system is a partner with

NOAA and presumed to be coordinated through the NTIA. However, the Swarm satellite transmissions meet the Interference Protection Criteria (IPC) for meteorological satellites[3] in the 137-138 MHz band, where the total signal power from a Swarm satellite into a METOP ground receiver is never greater than -140.8 dBW for any angle of arrival and assuming a non-directional earth receive antenna with 0 dBi gain[4], which is less than the IPC of -136 dBW per 150 kHz. This same IPC is applicable for the NOAA N and NOAA KLM satellites, however those systems may employ higher gain earth stations. There is no frequency overlap with NOAA KLM and therefore no interference is expected. The NOAA N earth stations may have an isotropic gain as high as 10 dBi[5] and in this case the signal power from a Swarm satellite into a NOAA N ground receiver could reach -130.8 dBW exceeding the IPC. This however will be a rare situation where a Swarm satellite is transmitting at the same time the NOAA N earth station is pointed in the direction of the Swarm satellite (given a 10 dBi antenna has some directionality). In fact, potential interference conjunctions above -136 dBW/150 kHz IPC is estimated to occur less than 0.0059% of the time which just meets the IPC limit of less than 0.0063% of the time (as specified by the previously referenced ITU recommendation.) This is estimated as follows[6]: The Swarm transmissions will occur up to about 1.1% of the time daily over each ground station. The NOAA N satellite may transmit up to 3.3% of the time daily in the same area. A 10 dBi earth station antenna has a 6 dB beamwidth of approximately 72 degrees, which is about 16% sky coverage. This results in a potential interference conjunction exceeding -136 dBW into the earth station receiver no more than 0.0059% of the time. Therefore the experimental Swarm satellite system meets the IPC for both the METOP and NOAA N and coordination should not actually be required. Note that this estimate assumes the worst case scenario that the satellites share a similar orbit and equatorial crossing time and anything otherwise would yield a smaller conjunction percentage.

The GOES WEST satellite is a Geosynchronous system with a 148.545 MHz receiver and there is no potential for interference from a Swarm earth station due to its low transmit power and path loss. The Swarm earth station transmits with a maximum EIRP density of -56 dBW/Hz and with path loss the receivable power at the Geosynchronous orbit is -224 dBW/Hz. A GOES earth station transmits with an EIRP density of about 1.7 dBW/Hz and with path loss the receivable power at the GOES satellite is -165 dBW/Hz which is 59 dB higher than a Swarm signal and interference is very unlikely.

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[3] ITU R-REC-SA.1027-5, Table 1, Sharing Criteria at 137-138 MHz, Interfering signal power (dBW) should not exceed –136 dBW per 150 kHz more than 0.0063% of the time.

[4] The ITU SNS for METOP shows receive antenna type ND with 0 dBi isotropic gain.

[5] The ITU SNS for NOAA N shows receive antenna type ND with up to 10 dBi isotropic gain.

[6] Swarm transmissions: 1 minute duration * 4 contacts * 4 satellites / 1440 minutes/day = 1.11%,
NOAA transmissions: 12 minute duration * 4 contacts * 1 satellite / 1440 minutes/day = 3.3%,
NOAA earth station antenna sky coverage: PI*(72 deg beamwidth / 2)^2 / PI*(90 deg)^2 = 16%

There are three other satellite systems shown in the tables below deserving additional attention, IMDC, SI-SAT-BILIKIKI, and HOL-MG-A006. In all three cases there is potential frequency overlap and the USA is a designated coverage area in the ITU notices, however none of these systems have launched yet and have no US licenses or applications in at the FCC as of December 2017. The IMDC system is a single satellite by the company Innovative Solutions In Space in the Netherlands. It appears there will only be an earth station in the Netherlands. The SI-SAT-BILIKIKI and HOL-MG-A006 are both planned large Mobile Satellite Service constellations by Pangea Networks LLC and Hiber (formerly Magnitude Space) respectively. Pangea Networks is a US based company but filed their satellite system notification through the Solomon Islands administration. Hiber is a Netherlands based company and filed their satellite system notification through the Netherlands administration. In both cases, it is unknown by Swarm the status of their launch authorization licensing and construction progress. Neither entity has any space system licensing within the United States.

In these tables, red colored boxes indicate frequency overlap between the respective system in the row and the Swarm BEE system. Green rows indicate some level of coordination or additional consideration is required for the system.

Table 1: List of Satellite Systems in the ITU SNS, transmitting 137 - 138 MHz

Satellite	Country	Service Area	Freq Overlap (max freq shown)	Coordination requirement	Notes
AGILE	Italy	XVE Kenya ES	138	None	Equatorial NGSO, no orbital access to USA.
ATS-5	USA	GEO NC ES	...137.365	None	GEO, no frequency overlap
EUTELSAT-48E	France	GEO Belgium ES	...137.230	None	GEO, no frequency overlap
IMDC	Nether lands	XAA, Netherland ES	137.9-138 E-S, S-E	None	Not launched yet? No US license/stations Innovative Solutions In Space
IMP-J	USA	AK, NC ES	...137.995	None	Inactive, 1970's
LEOTELCOM-1	USA	XAX (world)	...137.325	Orbcomm Consent	No frequency overlap
LEOTELCOM-2	USA	XAX	...137.928	Orbcomm Consent	To be coordinated with Orbcomm
LEOTELCOM-5	USA	XAA	...137.655	Orbcomm Consent	No frequency overlap
MCSCS	China	XAA (world)	...137.525	None	No frequency overlap
METEOR-3M	Russia	XAA	...137.975	None	deactivated March 2006
METOP	France	XAA	...137.988	None IPC met	To be coordinated w/ NTIA? IPC met
NOAA N	USA	XAA	...137.932	NTIA consent IPC met	To be coordinated w/ NTIA IPC met
NOAA-KLM	USA	XAA	...137.793	None	No frequency overlap
RS-D2	India	IND (India)	...137.550	None	No area or frequency overlap

SAUDISAT-1C	Saudi Arabia	ARS (Saudi Arabia)	...137.525	None	No area or frequency overlap
SAUDISAT-2	Saudi Arabia	ARS	...137.513	None	No area or frequency overlap
SEO BHASKARA-1	India	IND	...137.990	None	No area overlap, 1980's
SEO BHASKARA-2	India	IND	...137.990	None	No area overlap, 1980's
SI-SAT-BILIKIKI (300 satellites)	Solomon Island	XAA	137-138 (1 MHz)	None	Not launched yet No US license/stations Pangea Networks
SROSS-1	India	IND	...137.690	None	No area or frequency overlap 1990's

Table 2: List of Satellite Systems in the ITU SNS, receiving 148 - 150.05 MHz

Satellite	Country	Service Area	Freq Overlap (closest freq shown)	Coordination requirement	Notes
AGILE	Italy	XVE space to space link	149.0 2 MHz	None	No area overlap Equatorial orbit Leotelcom-1 space link
ATS-5	USA	GEO NC ES	148.26 30 kHz	None	No frequency overlap
CASSIOPE-1A	Canada	XAA	150.005... Tx	None	No frequency overlap
GOES West	USA	GEO Wallops VA	148.545 30 KHz	NTIA Consent IPC met	To be coordinated w/ NTIA IPC met
HOL-MG-A006 (140 satellites)	Netherlands	XAA	148-149.9 12 kHz	None	Not launched yet No US license/stations Magnitude Space (Hiber)
IMP-J	USA	AK, NC ES	148.98 30 kHz	None	No frequency overlap Inactive, 1970's
IPS	Netherlands	HOL	...148.118	None	No area or frequency overlap
IRS-1B, 1E	India	India	149.522 12 kHz	None	No area overlap
KITSAT-3	Korea	Korea	148.025,148.9 20 kHz	None	No area or frequency overlap
LEOTELCOM-1	USA	XAX (world)	148-150.05	Orbcomm Consent	To be coordinated with Orbcomm
LEOTELCOM-2	USA	XAX	148-148.905	Orbcomm Consent	To be coordinated with Orbcomm
LEOTELCOM-3	USA	XAX (world)	149.81-149.9	None	No frequency overlap
LEOTELCOM-5	USA	XAA	148-150.05	Orbcomm Consent	To be coordinated with Orbcomm
LUX-NGSO -1/2/3	Luxembourg	XAA	149.0-151.0	None	No frequency overlap
MCSCS	China	XAA (world)	149.025 44 kHz	None	No frequency overlap No US stations

RS-D2	India	IND (India)	...148.265	None	No area or frequency overlap
S4P	Swiss	HOL, SUI	148.2635 -148.5865	None	No area overlap
SAUDISAT-1C	Saudi Arabia	ARS (Saudi Arabia)	149.025 44 kHz	None	No area or frequency overlap
SEO BHASKARA-1	India	IND	...148.265, 148.595...	None	No area or frequency overlap 1980's
SEO BHASKARA-2	India	IND	...148.265, 148.595...	None	No area or frequency overlap 1980's
SI-SAT-BILIKIKI	Solomon Island	XAA	149.025 100 kHz	None	No frequency overlap No US license/stations
SROSS-1,-3	India	IND	149.272...	None	No area or frequency overlap
TELEOS-1	SNG	SNG	148.6875...	None	No area or frequency overlap
TSYKADA	Russia	XAA	149.903...	None	No frequency overlap
YOUTHSAT	India	XAX	149.995...	None	No frequency overlap

Radio Astronomy Service protection

Pursuant to the ITU Radio Regulations 5.208A, Swarm BEE's meet the ITU recommendations[7] to avoid interference with the nearby Radio Astronomy Service (RAS) band (150.05-153 MHz). The space BEE's transmit only in the 137-138 MHz band and out of band emissions are minimized by digital modulation techniques and filtering with at least 85 dB spectral roll-off [8] at 150 MHz resulting in a power flux density (pfd) at Earth's surface not exceeding -272.5 dB(W/(m^2 · Hz)) thereby meeting the RAS protection criteria of -259 dB(W/(m^2 ·Hz))[9].

Ground BEE's transmit in the adjacent band 148-149.9 MHz and employ the same digital modulation techniques and filtering as Space BEE's with at least 70 dB spectral rolloff at 150.05 MHz from a transmit frequency at 148.5 MHz. Nevertheless Ground BEE's will be positioned at a distance or otherwise obstructed such to prevent line-of-site observations by a Radio Astronomy site using the 150.05-153 MHz band[10] and resulting in a signal attenuation that meets the RAS interference protection criteria. In addition, the frequency of transmissions from the Swarm earth stations is much less

[7] ITU Radio Regulations, Resolution 739 (Rev. WRC-15) and Recommendation ITU-R M.1583.

[8] Measured performance at 150 Mhz is -86 dBc within the limits of the test equipment and likely exceeds this performance in the RAS bands. -80 dBc occurs at 3 Mhz from the carrier.

[9] As specified in ITU-R M.1583, the protection criteria is -238 dB(W/m^2) in a 2.95 MHz reference bandwidth and as recommended in ITU-R RA.769-2 Table 1, the threshold for harmful interference is -259 dB(W/(m^2 · Hz)) at a center frequency 151.525 MHz.

[10] Recommendation ITU-R RA.769-1 specifies "above about 40 MHz sharing may be practicable with services in which the transmitters are not in direct line-of-sight of the observatories".

than 2% of the time[11] which also meets the RAS protection criteria[12].

Conclusion

The experimental satellites and US earth stations pose no risk of creating harmful interference with any known system with the exception of Orbcomm. As represented above, Swarm satellite transmissions are compliant with the frequency allocation tables and meet PFD based protection criteria for terrestrial systems and RAS as well as meteorological satellite systems. Swarm will seek specific consent from Orbcomm to mitigate any potential for interference with their system.

[11] The experimental transmissions are at a maximum of 1 minute durations 16 times per day (~1.1% of the time). This accounts for 4 satellites with up to 4 contacts each per day.
[12] ITU RR 2016, Resolution 739, article g, and ITU-R RA.1513-2, article 2.