Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
TELESAT CANADA	)	Call Sign: S2991
Petition for Declaratory Ruling to Grant Access to the U.S. Market for Telesat's V-Band NGSO Constellation	)	File No. SAT-PDR-20170301-00023

COMMENTS OF SPACE EXPLORATION HOLDINGS, LLC

Space Exploration Holdings, LLC ("SpaceX") hereby comments on the application filed by Telesat Canada ("Telesat") for authority to serve the U.S. market with its non-geostationary satellite orbit ("NGSO") system providing Fixed-Satellite Service ("FSS") using V-band spectrum. The proposed system would consist of at least 117 satellites in a combination of circular polar orbits at an altitude of 1,000 km, and inclined orbits at an altitude of 1,248 km.[1] The system also includes optical inter-satellite links ("ISLs"), which will allow Telesat to route traffic through satellites in the same or adjacent orbital planes.

As proposed, the Telesat system includes many technical characteristics that may facilitate coordination and spectrum sharing with other NGSO systems. Small, agile beams help to enhance spectral efficiency through a high level of frequency reuse. In addition, the use of small beams generally decreases the number of in-line events that a Telesat satellite is likely to experience with other systems, the duration of those in-line events, and

[1] *See Petition for Declaratory Ruling to Grant Access to the U.S. Market for Telesat's V-Band NGSO Constellation*, IBFS File No. SAT-PDR-20170301-00023, at 5 (Mar. 1, 2017) ("Telesat Petition").

the odds that a given satellite will experience in-line events with multiple operators at one time. ISLs offer additional flexibility to route traffic in ways that can avoid conflicts with other NGSO operations. Thus, the Telesat system will have the tools to operate efficiently and cooperatively with other NGSO systems.

As discussed more fully below, however, Telesat proposes to use very high-EIRP earth station uplink beams, which are likely to cause interference to other low-Earth orbit ("LEO") systems. The Commission should consider how best to address this issue in order to ensure that valuable spectrum resources can be shared equitably and efficiently.

I. TELESAT'S HIGH-EIRP OPERATIONS MAY CAUSE INTERFERENCE TO ANY LEO SATELLITE WITHIN OR NEAR ITS UPLINK BEAMS, EVEN OUTSIDE AN IN-LINE EVENT

Although both SpaceX and Telesat propose to operate at LEO altitudes, Telesat's uplink beams will transmit at EIRP levels much higher than SpaceX's. With such a large EIRP disparity, the Telesat uplink beam would likely degrade SpaceX's or any other LEO satellite's ability to receive any uplink signal in the affected band from *any* location on the Earth, whether or not it is near the transmitting Telesat earth station. This would essentially prevent a LEO satellite with steerable beams from using that steering capability to avoid an in-line event, forcing both operators to default to band segmentation.

To illustrate this point, we consider two in-line scenarios involving the NGSO systems proposed by Telesat and SpaceX, and use operational parameters from their respective applications to determine the impact (measured as $\Delta T/T$) of these in-line events. In Scenario 1, the SpaceX very low-Earth orbit ("VLEO") satellite is in the main beam of the Telesat earth station uplink beam. In this scenario, SpaceX has the ability to redirect beams to serve areas unaffected by the in-line event. Tables 1 and 2 set forth the analysis

of the impact on SpaceX in this scenario from 60 centimeter and 1.8-meter Telesat earth stations, where the SpaceX beams have been redirected to achieve 20 degrees of angular separation from the SpaceX satellite's point of view. As this analysis demonstrates, the uplink beam from a Telesat earth station would cause a dramatic increase in noise temperature relative to the desired signal at the receive antenna of SpaceX VLEO satellites, with ΔT/T of 182% and 372%, even assuming 20 degrees of angular separation.[2]

SpaceX SAT Rx antenna gain at nadir [dB]	41.00	
SpaceX SAT Rx antenna G/T at nadir [dB/K]	14.30	*see SpaceX FCC filing*
SpaceX SAT Rx antenna G/T at 20º [dB/K]	-27.23	*32-25log(φ) at 20° separation*
Telesat ES Tx power [dBW/Hz]	-69.50	*per Telesat (see Table 12)*
Telesat ES Gmax [dB]	47.50	*per Telesat (see Table 12)*
Telesat ES EIRP [dBW/Hz]	-22.00	
I/N [dB]	**2.61**	*at 20° separation*
ΔT/T [%]	**182**	*at 20° separation*

Table 1. Impact of 60 cm Telesat Earth Station in Scenario 1

SpaceX SAT Rx antenna gain at nadir [dB]	41.00	
SpaceX SAT Rx antenna G/T at nadir [dB/K]	14.30	*see SpaceX FCC filing*
SpaceX SAT Rx antenna G/T at 30º [dB/K]	-27.23	*32-25log(φ) at 20° separation*
Telesat ES Tx power [dBW/Hz]	-76.00	*per Telesat (see Table 12)*
Telesat ES Gmax [dB]	57.10	*per Telesat (see Table 12)*
Telesat ES EIRP [dBW/Hz]	-18.90	
I/N [dB]	**5.71**	*at 20° separation*
ΔT/T [%]	**372**	*at 20° separation*

Table 2. Impact of 1.8 m Telesat Earth Station in Scenario 1

In Scenario 2, the SpaceX and Telesat earth stations are essentially collocated while their satellites have an apparent angular separation of 10 degrees (*i.e.*, the edge of an in-line event). Here again, the analysis in Tables 3 and 4 (for 60 centimeter and 1.8-meter

[2] For purposes of this analysis, SpaceX used a representative frequency (49 GHz) and representative orbital altitude for the VLEO portion of its system (335.9 km), and EIRP values for Telesat earth stations taken from Table 12, page 13 of Appendix A to the Telesat Petition. I/N is calculated using this equation (where k = Boltzmann constant):

$$\frac{I}{N} = EIRP - 10\log(4\pi d^2) - 10\log\left(\frac{4\pi}{\lambda^2}\right) + \frac{G}{T} - 10\log(k)$$

antennas, respectively) demonstrates that the high-EIRP transmissions from the Telesat earth station would cause a dramatic increase in interference, with ΔT/T of 231% and 52%, respectively.

SpaceX SAT Rx antenna G/T at nadir [dB/K]	14.30	*see SpaceX FCC filing*
Telesat ES Diameter D [m]	0.60	
Telesat ES Gmax [dB]	47.50	*per Telesat (see Table 12)*
Telesat Gain @ 10° [dB]	7.00	*32-25log(φ), per Rec. ITU-R S.465-6*
Telesat ES Tx power [dBW/Hz]	-69.50	*per Telesat (see Table 12)*
Telesat ES EIRP @ 10° [dBW/Hz]	-62.50	
I/N [dB]	**3.63**	*at 10° separation*
ΔT/T [%]	**231**	*at 10° separation*

Table 3. Impact of 60 cm Telesat Earth Station in Scenario 2

SpaceX SAT Rx antenna G/T at nadir [dB/K]	14.30	*see SpaceX FCC filing*
Telesat ES Diameter D [m]	1.80	
Telesat ES Gmax [dB]	57.10	*per Telesat (see Table 12)*
Telesat Gain @ 10° [dB]	7.00	*32-25log(φ), per Rec. ITU-R S.465-6*
Telesat ES Tx power [dBW/Hz]	-76.00	*per Telesat (see Table 12)*
Telesat ES EIRP @ 10° [dBW/Hz]	-69.00	
I/N [dB]	**-2.87**	*at 10° separation*
ΔT/T [%]	**52**	*at 10° separation*

Table 4. Impact of 1.8 m Telesat Earth Station in Scenario 2

In Scenario 1, interference is so strong that it would prevent the SpaceX satellite from using its steerable beams to service other users (even outside the area subject to the in-line event) using spectrum shared with Telesat, and thus essentially prevents SpaceX from using those frequencies anywhere during the in-line event. In Scenario 2, because SpaceX will experience an unacceptable level of interference without a separation angle much larger than 10 degrees, the operators would have to expand the in-line event zone, which would negatively affect spectral efficiency and usable capacity for both systems.

Without effective coordination, this pervasive interference will significantly reduce the overall utility of NGSO operations throughout the band. The Commission is currently

considering whether to adopt default limits for EIRP density of NGSO uplink transmissions in order to facilitate spectrum sharing among systems,[3] and SpaceX believes that such limits will be critical to equitable and efficient spectrum sharing among non-homogeneous NGSO systems. At a minimum, any grant of Telesat's application should be conditioned upon compliance with the outcome of that rulemaking proceeding. The Commission should also consider whether it would be appropriate to impose additional conditions to address this potential interference and enhance the potential for efficient spectrum sharing.

II. THE COMMISSION SHOULD GRANT VARIOUS WAIVERS REQUESTED BY TELESAT

In its application, Telesat has requested a variety of waivers for operation of its V-band system. For the reasons discussed below, SpaceX supports the following requests.

- *Request for waiver to operate in the 50.4-51.4 GHz band.* Telesat has requested a waiver of Section 25.202(a)(1) of the Commission's rules so that it would be able to operate its system using the 50.4-51.4 GHz band.[4] The situation with respect to this band is a bit unusual. The Commission's domestic table of allocations identifies this band as available for FSS (Earth-to-space) use on a co-primary basis, but the Commission has not made a corresponding entry in Section 25.202(a)(1). A waiver may not be required under these circumstances, but it clearly should be granted to the extent deemed necessary.[5]

---

[3] *See Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 31 FCC Rcd. 13651, ¶¶ 28-30 (2016) ("*NGSO NPRM*").

[4] Telesat Petition at 25-26.

[5] The Commission recently proposed to eliminate the list of FSS frequencies in Section 25.202(a)(1) and rely solely on the spectrum identified in the allocation tables in order to avoid just this sort of confusion. *See NGSO NPRM* ¶ 14.

- *Request for waiver to access spectrum previously licensed to GSO systems.* Telesat requests a waiver of Section 25.156(d)(5),[6] which provides that the Commission will not consider NGSO-like applications after it has granted a GSO-like application unless and until the Commission establishes NGSO/GSO sharing criteria for that frequency band. This provision may be interpreted to be applicable to the V-band because the Commission has not adopted specific service rules or GSO/NGSO sharing criteria for this band, and it has issued two prior authorizations for systems operating in portions of this band. The first such authorization was issued to a hybrid GSO/NGSO system,[7] while the second was issued to a single-satellite GSO system.[8] Neither system was ever deployed, however, and both licensees have since surrendered their authorizations. When the Commission adopted Section 25.156(d)(5), it specifically stated that it would treat a hybrid GSO/NGSO system "as an NGSO-like system, with the GSO portion of the system as additional satellites" for purposes of this rule.[9] Thus, because the first application granted in this band meets the NGSO-like application grant requirement, this rule should be no bar to further NGSO-like applications.
- *Request for waiver of band segmentation rule.* Telesat has requested a waiver of Section 25.157(e),[10] which establishes certain band segmentation procedures if

---

6 Telesat Petition at 27.

7 *Northrop Grumman Space & Mission Systems Corp.*, 24 FCC Rcd. 2330 (IB 2009).

8 Stamp Grant, Hughes Network Systems, LLC, IBFS File No. SAT-LOA-20111223-00248 (Aug. 3, 2012).

9 *See Amendment of the Commission's Space Station Licensing Rules and Policies*, 18 FCC Rcd. 10760, ¶ 58 (2003).

10 Telesat Petition at 27-28.

there is not sufficient spectrum available to accommodate all qualified applicants in a processing round. In considering various approaches for intra-service sharing among NGSO FSS applicants in other bands, the Commission has rejected approaches that applied band segmentation, finding that they "are overly restrictive, and could result in insufficient spectrum for commercially viable operations."[11] The Commission preferred the Avoidance of In-line Interference Events approach, under which all NGSO FSS licensees could use the entire band at issue, except in situations where two or more NGSO systems experience in-line interference, when they would have to coordinate.[12] The Commission found that this approach would best meet its goals of allowing equal access to the available spectrum, avoiding spectrum warehousing, and encouraging system flexibility to promote spectrum coordination.[13] The Commission should not now revert to imposing the automatic band segmentation approach upon the participants in this NGSO processing round. Rather, the Commission should waive the band segmentation requirements of Section 25.157(e) to the extent necessary. Successful coordination among NGSO systems will yield much more productive use of valuable spectrum and orbital resources than would a rigid band segmentation approach.

III. CONCLUSION

Telesat's proposed V-band NGSO system has many attributes that can facilitate spectrum sharing with other NGSO systems. However, the Commission must evaluate the

---

[11] *See Establishment of Policies and Service Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band*, 17 FCC Rcd. 7841, ¶ 37 (2002).

[12] *Id.* ¶¶ 39-52. For those NGSO systems operators that are unable to reach a coordination agreement, the Commission adopted a default sharing approach based on frequency isolation. *Id.* ¶¶ 53-55.

[13] *Id.* ¶¶ 27-38.

proposed system to ensure that its operations will not compromise the operations of other NGSO systems proposed in this processing round. By doing so, the Commission can ensure that all interested parties have an opportunity to make efficient use of V-band spectrum to meet the growing demands of U.S. consumers for advanced broadband services.

Respectfully submitted,

SPACE EXPLORATION HOLDINGS, LLC

By: */s/ Tim Hughes*
Tim Hughes
Senior Vice President, Global Business and Government Affairs

Patricia Cooper
Vice President, Satellite Government Affairs
SPACE EXPLORATION TECHNOLOGIES CORP.
1030 15th Street, N.W.
Suite 220E
Washington, DC 20005
202-649-2700

William M. Wiltshire
Paul Caritj
HARRIS, WILTSHIRE & GRANNIS LLP
1919 M Street, N.W.
Suite 800
Washington, DC 20036
202-730-1300

Counsel to SpaceX

September 25, 2017

ENGINEERING CERTIFICATION

The undersigned hereby certifies to the Federal Communications Commission as follows:

(i) I am the technically qualified person responsible for the engineering information contained in the foregoing Comments,

(ii) I am familiar with Part 25 of the Commission's Rules, and

(iii) I have either prepared or reviewed the engineering information contained in the foregoing Comments, and it is complete and accurate to the best of my knowledge and belief.

Signed:

/s/ Mihai Albulet

Mihai Albulet, PhD
Principal RF Engineer
SPACE EXPLORATION TECHNOLOGIES CORP.

September 25, 2017

Date

CERTIFICATE OF SERVICE

I hereby certify that, on this 25th day of September, 2017, a copy of the foregoing Comments was served by U.S. mail upon:

Henry Goldberg
Joseph A. Godles
Devendra T. Kumar
Goldberg, Godles, Wiener & Wright, LLP
1025 Connecticut Avenue, N.W.
Washington, DC 20036

/s/ *Abigail Hylton*
Abigail Hylton