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

In the Matter of	)	
	)	
Telesat Canada	)	File No. SAT-PDR-20161115-00108
	)	
Petition for Declaratory Ruling to Grant Access to the U.S. Market for Telesat's NGSO Constellation	)	

TELESAT CANADA'S RESPONSE TO COMMENTS OF WORLDVU SATELLITES LIMITED

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In the above-referenced Petition for Declaratory Ruling ("Petition"), Telesat Canada ("Telesat") seeks access to the U.S. market for Telesat's planned low earth orbit ("LEO"), non-geostationary satellite orbit ("NGSO") satellite system (the "Telesat LEO Constellation" or "LEO Constellation"). WorldVu Satellites Limited, doing business as OneWeb ("OneWeb"), filed Comments with respect to Telesat's Petition. [1] Telesat hereby responds to OneWeb's Comments.

I. INTRODUCTION AND SUMMARY

Telesat's LEO Constellation will be comprised of over 100 advanced satellites that will deliver high capacity, high speed, low latency data services with a distributed space architecture designed to enhance network security and resiliency and the ability to provide coverage anywhere in the world. The innovative design combines polar and

[1] *Comments of WorldVu Satellite Limited*, File No. SAT-PDR-20161115-00108 (filed June 26, 2017) ("*OneWeb Comments*").

inclined orbits, incorporates advanced technologies that will make effective and efficient use Ka-band spectrum to bring needed services to the public, including many presently underserved areas. Innovation, Science and Economic Development Canada (formerly Industry Canada) has authorized Telesat to launch and operate this LEO Constellation and Telesat has filed the Petition for authority to serve the U.S. market.

OneWeb was recently granted conditional access to the U.S. market for its own NGSO constellation, subject to the outcome of a rulemaking on the rules to govern such constellations.[2] OneWeb has raised questions concerning Telesat's Petition and an associated filing Telesat made in response to a letter from the International Bureau's Satellite Division.[3] OneWeb claims resolution of these questions is necessary to address what it characterizes as "the physical coordination and space debris issues presented by [Telesat's] proposed orbital altitude, which overlaps with the OneWeb constellation."[4]

As discussed below, OneWeb has not shown any basis in the FCC's rules or in international rules and regulations for its suggested 125 kilometer "Safety Buffer Zone" around its NGSO constellation and other NGSO constellations. OneWeb also has not provided any technical analysis for its proposal. Physical spacing of LEO constellations

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[2] *See WorldVu Satellites Limited, Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb NGSO FSS System,* IBFS File No. SAT-LOI-20160428-00041, Order & Declaratory Ruling, FCC 17-77 (rel. June 23, 2017) ("*OneWeb Grant*").

[3] *See Letter from Elisabeth Neasmith, Telesat, to Jose Albuquerque, Chief, FCC Satellite Division, regarding response to March 15, 2017 letter requesting additional information regarding Telesat's Petition for Declaratory Ruling Requesting Access to the U.S. Market for Its Non-Geostationary Orbit Constellation,* Call Sign S2976 IBFS File No. SAT-LOI-20161115-00108 (April 14, 2017) ("*Telesat's Response Letter*"). *See also Letter from Jose Albuquerque, Chief FCC Satellite Division, to Elisabeth Neasmith, Telesat Canada regarding Telesat Canada's Petition for Declaratory Ruling,* Call Sign S2976, IBFS File No. SAT-LOI-20161115-00108 (March 15, 2017) ("*Satellite Bureau Inquiry*").

[4] *OneWeb Comments* at 2.

needs to be resolved through coordination among all LEO operators not by establishing a large exclusion zone around any one LEO operator's constellation to the detriment of the other operators. Telesat stands ready to work with OneWeb and other operators of NGSO constellations to work out appropriate physical spacing among their constellations, just as the Commission has required OneWeb to do.

With regard to the other matters raised by OneWeb: (i) Telesat responds to OneWeb's list of informational requests regarding Telesat's orbital debris mitigation showing; and (ii) Telesat demonstrates that its EPFD and coverage showings satisfy Commission requirements.

II. TELESAT'S EXPERIENCE AND TECHNICAL QUALIFICATIONS AND EXPERTISE ARE UNPARALLELED

In its Comments, OneWeb implicitly questions Telesat's experience, technical qualifications and expertise to implement its NGSO system, including Telesat's capability to guard against collisions. There is no basis for OneWeb's stated concerns.

As more fully set forth in its Petition, since launching the first domestic commercial geostationary satellite in 1972, Telesat has evolved into an international, diversified, and end-to-end satellite services company, with an unparalleled reputation for innovation, technical and operational expertise and customer service. Telesat has been an industry leader in collision avoidance and reducing debris in the space environment for 2 decades, most particularly since the 1997 failure of Telstar 401. Telesat designs and operates satellites to avoid debris generation both during mission

and post-disposal by following and regularly exceeding international standards for deorbit and pacification.

Telesat shares its satellites' ephemeris data with JSpOC, CANSpOC, the Space Data Association, the Canadian Space Agency, MIT Lincoln Labs, and fellow operators both routinely and upon request (currently including NASA, Star One and EchoStar for near orbit coordination operations).

Telesat receives high-precision orbits for passive space objects from MIT Lincoln Labs to further refine Space Situational Awareness (SSA) conjunction assessments. MIT/LL also supports periodic calibration of Telesat's tracking systems. These measures increase the accuracy of our orbit determination process and improve Telesat's situational awareness.

Through Telesat's prime involvement in the RadarSat 2 mission, Telesat holds the Flight Dynamics and Satellite Engineering Lead role. As such JSpOC collision avoidance notifications are analyzed and implemented as required, using proven collision avoidance software and accepted statistical best practices for LEO SSA.

In summary, during its almost 50 years of history Telesat has met all international and domestic regulatory requirements for orbit housekeeping and disposals of its retired spacecraft. Telesat intends not only to comply with the current de-orbiting and debris mitigation requirements, but to continue to be a leader in the in-orbit housekeeping community.

III. ONEWEB'S REQUEST FOR A 125 KM "SAFETY BUFFER ZONE" IS INCONSISTENT WITH COMMISSION PRECEDENT, UNSUPPORTED, AND COUNTERPRODUCTIVE

OneWeb proposes that Telesat be required to maintain an approximate 125 km altitude buffer zone, which OneWeb describes as a "Safety Buffer Zone," between its constellation and OneWeb's constellation, "subject to physical coordination with OneWeb."[5] The Commission already has considered and resolved this issue in connection with OneWeb's application. OneWeb's proposal conflicts with the Commission's prior determination.

The Commission has addressed this issue by requiring that NGSO operators work cooperatively to coordinate the physical operation of their spacecraft to avoid collisions. To that end, only two weeks ago the Commission conditioned its grant of market access to OneWeb on compliance with the following condition:

> "OneWeb must coordinate physical operations of spacecraft with any operator using similar orbits, for the purpose of eliminating collision risk and minimizing operational impacts. The orbital parameters specified in this grant are subject to change based on such coordination "[6]

OneWeb's proposal conflicts with the Commission's prior holding both because (i) it would elevate OneWeb's system above other systems by requiring other operators to coordinate with OneWeb, rather than making it a matter of mutual discussions and agreement, and (ii) it would mandate a predetermined 125 km altitude between

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[5] *Id*. OneWeb also contends that Telesat should have to maintain this altitude separation with other NGSO systems. *Id*.

[6] *OneWeb Grant* at ¶25 (d).

satellites. OneWeb offers no support, technical or precedential, for its conflicting proposal.

The duty that the Commission placed upon OneWeb is clear: it must coordinate the physical operations of its spacecraft with other operators using similar orbits, including Telesat. Nothing gives OneWeb priority in its coordination with Telesat or entitles OneWeb to a 125 km altitude buffer which, as discussed below, could effectively prevent Telesat from operating in low earth orbit.

Furthermore, OneWeb presents no engineering analysis for its proposed altitude separation, and in fact NGSO satellites can and do operate at distances much closer than 125 km.[7] For example, Iridium and Orbcomm operate constellations separated by less than 30 km in altitude.[8] Similarly, OneWeb cites no Commission or international rule or regulation in support of its position.

Taken to its logical extreme, and assuming, as OneWeb apparently does that it has been ceded an altitude of 1200 km, OneWeb's proposed "Safety Buffer Zone," taken together with Iridium's operations at 780 km, Boeing's proposed orbits of 1030 to 1080

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[7] Factors that can affect necessary distances between constellations, include cooperation between neighboring operators, especially in the cases of polar orbit constellations vs. inclined Walker-type constellations, where the co-operative placement of the argument of perigee and choice of eccentricity can increase separation, and other colocation strategies used in geostationary operations, of which Telesat, with almost 50 years of satellite operating experience, is very familiar. Minimum standards of operation as well as operator competence are other significant factors in assessing how close in physical proximity it is safe for constellations to operate.

[8] *See Application of Iridium Constellation LLC for Modification of License to Authorize a Second-Generation NGSO MSS Constellation,* File Nos. SAT-MOD-20131227-00148, SAT-AMD-20151022-00074, Call Sign S2110, DA 16-875 (IB 2016) at ¶2*; see also Application of Orbcomm License Corp. For Authority to Modify its Non-Voice, Non-Geostationary Satellite System,* Order and Authorization, 23 FCC Rcd 4804 (IB and OET 2008).

km, and GlobalStar's operations at 1414 km would take up the entire low earth orbit space.[9]

Rather than overturning its precedent based on a OneWeb argument that lacks technical or legal support, the Commission should adopt a physical coordination condition for Telesat that is comparable to the condition it adopted as to OneWeb.

OneWeb's contention that the need for "greater certainty in the shared orbital environment" is sufficient justification to deny Telesat's flexibility to grow its constellation is equally unavailing. As with the case of the physical altitude of satellite constellations, Telesat urges the Commission to reject OneWeb's efforts to prevent OneWeb's competitors from using LEO orbits and spectrum to its fullest.

For all of these reasons, OneWeb's proposal for a 125 km altitude separation should be rejected.

IV. ONEWEB'S REQUEST FOR ADDITIONAL INFORMATION REGARDING ORBITAL DEBRIS IS UNNECESSARY, NEVERTHELESS, TELESAT PROVIDES SUCH INFORMATION.

OneWeb is insisting on far more information than the Commission itself requested of Telesat to evaluate Telesat's orbital debris mitigation showing. Nevertheless, to dispose of OneWeb's arguments, Telesat provides the following point by point response to OneWeb's informational requests:

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[9] *See The Boeing Company,* IBFS File Nos. SAT-LOA-20160622-00058 and SAT-AMD-20 170301-00030 (Call Sign S2966); *see also Stamp Grant, Globalstar Licensee LLC,* FCC Call Sign S2115, FCC File No. SAT-MOD-20130314-00030 (September 18, 2014).

- *"[T]he probability of collision with debris <1 cm that could result in loss of ability to deorbit"*[10]

Telesat's analysis (under NASA-STD 8719.14A Change 1 Requirement 4.5-2) has been done based upon conservative design assumptions, since a spacecraft manufacturer and deployed configuration of subsystems are to be finalized. Based upon those assumptions, the risk is 0.000629 and is therefore compliant with NASA standards. Telesat is cognizant of the various design solutions to mitigate debris <1 cm and will ensure such solutions are incorporated into the spacecraft designs to meet or exceed the NASA standard.

- *[T]he accuracy with which orbital parameter knowledge will be maintained"*[11]

As per Telesat's previous response to this question from the Satellite Division,[12] Telesat's space station orbit parameters will be maintained with the following accuracy:

Apogee or Perigee Altitude	300 meters
Inclination	0.04 degrees
Right Ascension of the Ascending Node	1 deg

[10] *OneWeb Comments* at 3.
[11] *Id.*
[12] *Telesat's Response Letter* at 4.

In response to OneWeb's question as to how these parameters should be interpreted, [13] Telesat adds the following information:

Apogee or Perigee Altitude This value is in relation to the target apogee and target perigee, not mean altitude.	300 meters
Inclination This value is in relation to the target mean inclination, not osculating inclination.	0.04 degrees
Right Ascension of the Ascending Node This value is in relation to the target ascending node. For Walker constellation this is referenced to the key satellite, not a particular RAAN (0-360 deg).	1 deg

Target values are determined by Walker orbit design and phasing for the inclined constellation. Target values are determined by initial polar orbit deployment and phasing for the polar constellation, as this configuration is sun synchronous.

- *"[T]he risk to the International Space Station ("ISS") posed by deorbiting Telesat satellites"* [14]

Calculated using the NASA DAS program for the probability of collision with an object of greater than 10 cm, the collision risk, per satellite, rounded to five decimals, is 0.00000. Given that the probability of collision is less than the resolution of the DAS software, the aggregate risk for the entire constellation would also therefore be near zero.

The values shown above reflect a recent Telesat determination to use highly elliptical orbits of approximately 750 km x 150 km to deorbit its satellites. This

[13] *OneWeb's Comments* at 4.
[14] *Id.* at 3.

determination follows up on Telesat's statement in its Response Letter that it was analyzing a more efficient elliptical orbit configuration with lower perigees for de-orbiting to minimize the fuel usage, time in the disposal orbit and debris generation. This information also resolves OneWeb's questions about Telesat's intended disposal orbit.

At the time of entry into disposal phase, Telesat will custom design disposal orbit parameters that minimize probability of collision with the International Space Station (ISS). To pre-predict the required parameters about 15 years in advance would be premature, but Telesat is experienced in eccentricity and inclination collocation and probability of collision avoidance strategies. At this eccentricity, even a passive disposal strategy, with properly chosen argument of perigee and orbital parameters, will create significant separation.

- "*[T]he quantity of fuel being reserved for deorbit*"[15]

This determination will be made upon finalization of satellite design and operating experience. Telesat notes in this regard that it has found chemical propulsion residuals will be significantly different than ion propulsion residuals due to different operating strategies. In any event, Telesat will reserve sufficient fuel for the energy required, with margin, for deorbit.

[15] *Id.*

- "*the method for addressing fuel gauging uncertainty*"[16]

Telesat will use both individually, and as a cross check against each other, manufacturer baseline empty tank thermal testing, in orbit thermal testing, cross fleet analysis and trending, and bookkeeping backed by orbital performance, updated as required by such testing methods that may be developed over time. Telesat is familiar with and has experience with all of the above cited methods both for ion and chemical satellite propellant gauging.

- "*with respect to intra-constellation conjunctions, the nominal miss distances, sensitivities of these miss distances to orbital parameter variations, and the constraints this imposes on station-keeping requirements*"[17]

Intra-constellation satellite separations are expected to be smaller near the poles for the polar constellation. This will be addressed by proper phasing of the satellites within each plane and will be managed by the operations team to avoid conjunctions. Intra-constellation satellite separations for the inclined constellation are taken into account by orbit parameter design. Telesat will be using a Walker constellation design (like Globalstar) and will fix and manage all satellite separations, constellation phase angles and orbit velocities to the "key" satellite's point of right ascension. All station-keeping required due to perturbations will be done in a distributed manner in relation to the constellation phasing.

In a Walker constellation, perturbations are generally distributed evenly across the constellation throughout the year and as such station-keeping strategies for each

[16] *Id.*
[17] *Id.*

satellite are necessarily referenced to the overall constellation station-keeping strategy. Intra-constellation nominal miss distances will be much larger then accepted probability of collision debris avoidance nominal miss distances. Telesat intends to share orbital information as it currently does on all of its operational satellites. This information will be shared with all interested operators.

- *Other Miscellaneous Issues Raised*

In addition to its catalogue of information requests, OneWeb raises several other questions, some of which have been addressed above; responses to other items follow:

> ••*OneWeb questions why in its response to questions from the Satellite Division, Telesat stated that the deorbit rate for its polar constellation will be eleven satellites per year and the deorbit rate for the inclined constellation will be fourteen satellites per year.*[18]

The question to which Telesat responded asked Telesat to make calculations for a 140 satellite deployment, without an indication as to the breakdown between satellites in Telesat's inclined and polar constellations. Telesat's conservative assessment for the worst case was to double the number of inclined orbit satellites which would be de-orbited, which explains what appears to be the higher rate for inclined orbit satellites. The assessment as provided in Telesat's response for the deorbit rate for inclined orbit satellites was thus deliberately conservative.

> ••*OneWeb questions several elements of Telesat's response to the Satellite Division Inquiry regarding the collision risk of its satellites, were there to be failures of Telesat's satellites resulting in their inability to perform collision avoidance procedures of 10, 5, and 1 percent*:

[18] *Id.* at 4-5.

First, responding to OneWeb's complaint regarding Telesat's extrapolation of DAS data for collisions below 700 km instead of performing a separate analysis using the DAS program for collision risks above 700 km,[19] Telesat has reviewed the issue, agrees with OneWeb that the DAS program does permit analysis for satellites above 700 km, and has conducted an analysis of collision probabilities under DAS at its mission altitudes. That analysis shows that the extrapolation method used in Telesat's Response Letter overstated the collision risks. Thus, calculated by planned orbital planes as described in Telesat's Response Letter and using the DAS software, yields a single failed spacecraft probability of collision in the polar constellation of 0.00097 and 0.00009 in the inclined constellation over a 12-year period, as compared with 0.0012 and 0.0002, respectively, as originally set forth in Telesat's Response Letter. For a two-spacecraft failure at the mission orbit, the overall collision probability would approximately double over 12 years, to 0.00194 and 0.00018 for the polar and inclined constellations respectively, as compared with 0.0024 and 0.0004, respectively for those constellations, as originally set forth in Telesat's Response Letter.

Second, OneWeb challenges Telesat's assertion that the failure of satellites in one orbital plane would pose no material risk to satellites operating in a different plane, stating that this analysis does not take into account the risk of collision between operational and non-operational satellites.[20] Yet, OneWeb does not explain why any

[19] *Id.* at 5.
[20] *Id.*

such added risk is any more or less than the risks normally taken into account by the DAS program analysis, including adjustments made in that program analysis as the space environment changes. Given the maneuver capability and other means that Telesat has to identify and avoid collisions with large space objects, based upon Telesat's operational experience, Telesat regards any additional risk as negligible and stands by its statement that there would be no material risk.

Third, OneWeb claims Telesat erred in responding to the Commission's inquiry on this subject by providing an analysis based upon failures by orbital plane instead of by constellation.[21] Telesat disagrees and has received nothing from the Commission questioning Telesat's approach. Nevertheless, to put this matter to rest, Telesat has conducted a further analysis using the worst case of all failures occurring on satellites in its polar orbit constellation, and has further conducted the analysis both with its minimum number of polar satellites, plus spares: 78, and a larger expanded number of 100 satellites.

Under this analysis, rounding up, a one percent failure equates to one satellite; a five percent failure equates to four satellites (out of 78) or five satellites (out of 100); and a ten percent failure equates to eight satellites (out of 78) or ten satellites (out of 100). Over a twelve year, applying the DAS software, the risks of collision with debris of greater than 10 cm are 0.00097 for one satellite; 0.00388 for four satellites; 0.00495 for five satellites; 0.00776 for eight satellites; and 0.0097 for ten satellites. As noted, this

[21] *Id*.

analysis assumes all failures occur in the polar constellation. The risk of collision from failures if they occurred in the inclined orbit constellation would be considerably less.

It should be noted, moreover, that while the responses address the Commission's hypothetical of uncontrolled orbit failures of up to 10%, Telesat fully expects the actual probability of a failed satellite, especially a failure that results in a loss of any maneuver control, to be less than one percent. Such reliability will be produced, among other ways, in the redundancy of critical subsystems, including in propulsion, mechanisms, sensors, spacecraft computer and power subsystems, as well as best practices in satellite operation by experienced and well-trained engineering personnel.

> ••*OneWeb concludes its discussion of orbital debris mitigation by noting the possibility that the Commission is considering modifying it standards as they apply to constellation systems and stating that a Telesat grant should be conditioned on Telesat's compliance with such revised standards.* [22]

As to the possibility of changes in the Commission's rules as to this or other matters, Telesat is ready to accept the same condition that the Commission specified for OneWeb, that a "grant of U.S. market access and any earth station licenses granted in the future are subject to modification to bring them into conformance with any rules or policies adopted by the Commission in the future."[23]

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[22] *Id.* at 6.
[23] *OneWeb Grant* at ¶26.

V. TELESAT'S EPFD ANALYSIS AND COVERAGE SHOWINGS SATISFY COMMISSION REQUIREMENTS

OneWeb also questions Telesat's EPFD and coverage showings. There is no apparent connection between these questions and the stated focus of OneWeb's Comments on "physical coordination and space debris issues."[24] In any event, Telesat addresses OneWeb's questions below.

A. Telesat's EPFD Analysis

OneWeb complains that Telesat has not submitted a PFD/e.i.r.p. mask, SRS database files, and other EPFD statistical analysis that OneWeb claims it needs to see to validate Telesat's EPFD compliance demonstration.[25] The Commission does not require such submissions for Ka-band applicants. Telesat has provided all of the EPFD-related information requested by the Commission.[26]

Independently of the Commission, the ITU conducts its own analysis of EPFD compliance. Telesat has submitted all required information to the ITU in connection with this analysis, and the ITU's finding, once concluded, is expected to be public information. Telesat has no objection to a condition on its grant that would be consistent with[27] the following condition the Commission specified for OneWeb: "Prior to initiation of service, OneWeb must receive a favorable or 'qualified favorable' finding

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[24] *OneWeb Comments* at 2.
[25] *Id.* at 6-7.
[26] *Telesat Response Letter* at 2-3 and Attachment 1.
[27] We note what appears to be a typographical error in the quoted OneWeb condition; we believe that the reference in the condition to "Recommendation 85 (WRC-03)" is intended to mean Resolution 85 (WRC-03).

in accordance with Recommendation 85 (WRC-03) with respect to its compliance with applicable EPFD limits in Article 22 of the ITU Radio Regulations."[28]

OneWeb, moreover, states that Telesat has not provided any assessment of the EPFD resulting from an inline event with a victim GSO earth station. This statement is factually wrong, as Telesat has provided such assessment in its application.[29]

In reference to the geometry of an inline event with a victim GSO earth station for operations in the 19.7-20.2 GHz band, OneWeb also seems to have misunderstood the meaning of the 32.8-degree discrimination angle indicated in the technical exhibit of the Telesat application, how this parameter was calculated and how it should be used in the assessment of how a non-GSO constellation complies with the ITU EPFD levels. To put this matter to rest, Telesat offers a further explanation here below.

The 32.8-degree discrimination angle is the minimum off-axis angle that a receiving GSO earth station with a 0.9m antenna whose reference antenna pattern is in accordance with Recommendation ITU-R S.1428 needs in order not to suffer from harmful interference when the Telesat LEO constellation generates a downlink EPFD of -190.4 dB(W/m^2/40 kHz) on the ground. Together with other relevant data, such discrimination angle is taken into account by the ITU Radiocommunication Bureau when it carries out the analysis in accordance with Resolution 85 (WRC-03).

Therefore, Telesat does not need to demonstrate that its satellite antennas provide 52 dB of what OneWeb calls "rejection at this exclusion angle". In fact, Telesat

[28] *OneWeb Grant* at ¶ 24.d.
[29] *See* Telesat's Petition, Appendix A, Technical Exhibit, at 17.

only needs to make sure that its LEO system meets the relevant ITU EPFD limits. Although the Commission does not require that applicants demonstrate that their proposed systems meet the abovementioned ITU EPFD limits, in order to address the specific case mentioned by OneWeb, Telesat is pleased to provide the chart below, showing that Telesat will be fully compliant with the ITU EPFD limits in the case cited by OneWeb.

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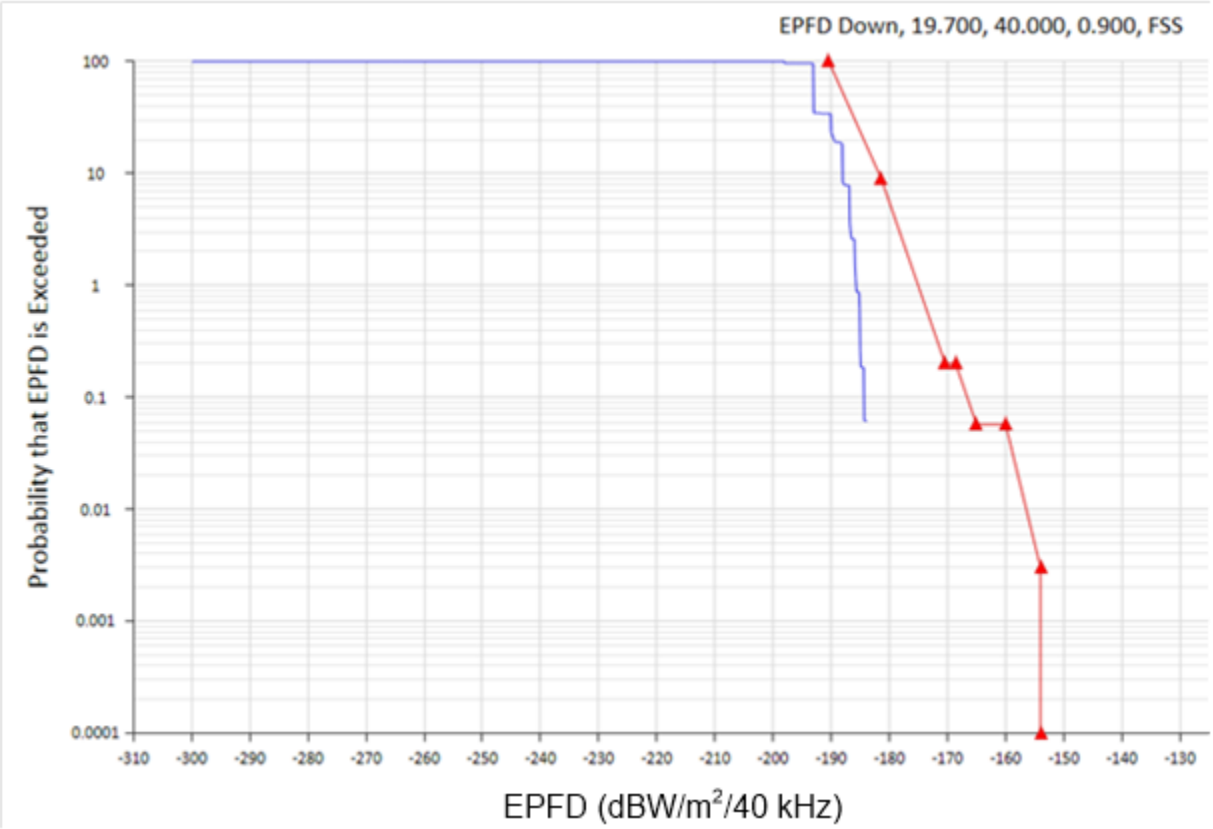
LEO Constellation EPFD Validation Results for the 19.7 – 20.2 GHz band using a reference antenna diameter of 0.9 m produced with the use of Visualyse[EPFD] software Version 3.1.8.1 from Transfinite Systems



B. Telesat's Coverage Showing

OneWeb identified a discrepancy in the numbers in Telesat's Schedule S and the remainder of Telesat's technical showing, including its coverage exhibit.[30] As OneWeb correctly surmised in its Comments,[31] the Right Ascension of Ascending Node (RAAN) values for Telesat's five inclined orbits are separated by 72°, *i.e.*, the RAAN values for

[30] *Id.* at 8-9.
[31] *Id.* at 8.

the 5 inclined orbits are 0°, 72°, 144°, 216°, and 288°. All the calculations, analysis, demonstrations, figures, and the video presented in Telesat's Petition are based on the 72° separation for the RAAN values for the inclined orbits. However, there were two typos in the RAAN values in Schedule S.[32] Specifically, in the Schedule S the RAAN values for the five inclined orbits were as shown in Table 1:

Table 1: The RAAN values from the submitted Schedule S which included typos

Orbital Plane Number in the Schedule S	RAAN [degrees]
6	0
7	36
8	72
9	108
10	144

The correct value of RAAN for Orbit 7 is 216° and the correct value of RAAN for Orbit 9 is 288°. Table 2 shows the correct RAAN values for the five Inclined Orbits.

[32] Contemporaneously herewith, Telesat is submitting an Erratum to its Petition to correct these typographical errors.

Table 2: The correct RAAN values for the 5 Inclined Orbits

Orbital Plane Number in the Schedule S	RAAN [degrees]
6	0
7	216
8	72
9	288
10	144

All of the calculations, analysis, and demonstrations presented in the Technical Exhibit of Telesat's Petition were based on the correct RAAN values of Table 2. Specifically, as noted in OneWeb's comments, Figure 2 of Telesat's Technical Exhibit corresponds to the correct RAAN values shown in Table 2. The coverage requirement demonstrations presented in Section A7 of the Technical Exhibit, including Figure 6 and Figure 8 of the Technical Exhibit correspond to the correct RAAN values shown in Table 2. The video submitted as part of Telesat's Petition (called Telesat-Simulation.wmv) corresponds to the satellite constellation with the correct RAAN values shown in Table 2. The ten snapshots of the simulation video presented in Annex 3 of the Technical Exhibit of Telesat's Petition correspond to the correct RAAN values of Table 2.

In summary, the typos appeared only in the Schedule S and did not affect any part of the calculations, analysis, pictures, video, and demonstrations presented in Telesat's Petition. As demonstrated in the Technical Exhibit, Telesat's LEO Constellation will meet the coverage requirements of Section 25.145 of the Commission's rules.

OneWeb's remaining "doubts" about Telesat's coverage and insistence on some unspecified, but more detailed information showing than presented in Telesat's Petition are not supported by any analysis on OneWeb's part and go beyond the requirements specified in the Commission's rules. Nevertheless, in response to OneWeb's "doubts," Telesat notes, as pointed out in Telesat's Petition, that its satellites will use Direct Radiating Array (DRA) antennas and beam forming to generate a minimum of 16 downlink user beams and a minimum of 16 uplink user beams, and that the user beams are steerable and shapeable. Each satellite will have two steerable spot beams for communication with gateways, and each satellite will have a wide-area receive beam (in addition to the above-mentioned user beams and gateway beams) that will allow the satellite to detect user requests to initiate communication.

Given this design, it is unclear why OneWeb has suggested that the use of the wide-area receive beam would prevent Telesat from providing continuous coverage. Based on the simulations performed by Telesat, the coverage requirements of Section 25.145 will be met with the associated earth stations operating at elevation angles of 10 degrees or more.

In any event, Telesat's Radio Resource Management system will use a combination of discrimination angles and adjustment of power levels as well as handovers to more suitably placed spacecraft as part of the mechanism to protect the geostationary satellite networks while maintaining continuous U.S. coverage.

VI. CONCLUSION

Telesat urges the Commission to grant Telesat's Petition, consistent with the action taken by the Commission with respect to OneWeb's own petition for access to the U.S. market. Nothing in OneWeb's Comments warrants delaying such favorable action.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I hereby certify that on this 7th day of July, 2017, a copy of the foregoing Reply to Comments of WorldVu Satellites Limited was sent by first-class, United States mail to the following:

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