Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Mitigation of Orbital Debris in the New Space Age	)	IB Docket No. 18-313
	)	

To: Federal Communications Commission

COMMENTS OF IRIDIUM COMMUNICATIONS INC.

April 5, 2019

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EXECUTIVE SUMMARY

Iridium supports the efforts of the Federal Communications Commission to update its rules relating to mitigation of orbital debris. However, throughout this process the Commission must be mindful of the operations of existing satellite constellations and the impact the influx of new satellites could have on the space environment, especially for satellites operating in low-Earth orbit. This evolving environment requires rules that are flexible, achievable, and sensitive to the investments that have made America a global space leader.

The Commission should adopt standards to promote safe flight profiles in low-Earth orbit, including requiring operators to quantify collision risk and should not authorize more than one constellation at a particular orbital altitude. Applicants proposing operations at orbital altitudes above 400 km should be required to explain and justify their planned operations, and should be required to include propulsion for deorbit and collision avoidance maneuvers. All non-geostationary orbit satellites operating between 400 km and 2,000 km should be disposed of promptly and reliably at the end of their mission life via atmospheric reentry, and deorbited satellites should not pose an unreasonable risk to people or property on the Earth.

Satellites must also be designed for reliability and trackability. Operators who launch satellites and experience in orbit failures should be required to identify the root cause of such failures prior to launching any additional satellites. All satellites must be designed to be trackable and operators should be required to maintain and share ephemeris data.

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I. INTRODUCTION

Iridium Communications Inc. ("Iridium") hereby responds to the Federal Communications Commission's ("Commission's" or "FCC's") notice of proposed rulemaking ("NPRM") to reform its rules regarding the mitigation of orbital debris consistent with developments in the space industry.[1] As the Commission appropriately moves to modify its rules, it must be mindful of the operations of existing satellite constellations and the impact the influx of new satellites could have on the space environment, especially for satellites operating in low-Earth orbit ("LEO"). This evolving environment requires rules that are flexible, achievable, and sensitive to the investments that have made America a global space leader.

II. BACKGROUND

In February 2019, Iridium completed the upgrade of its satellite constellation with Iridium® NEXT satellites, which support higher data speeds for new products, including the recently introduced Iridium Certus℠ broadband service.[2] As the new satellites came online

[1] *Mitigation of Orbital Debris in the New Space Age*, Notice of Proposed Rulemaking and Order on Reconsideration, FCC 18-159 (rel. Nov. 19, 2018) ("NPRM").

[2] Iridium Communications Inc., Annual Report (Form 10-K), at 2 (Feb. 28, 2019) ("Iridium 2018 Annual Report"), https://www.sec.gov/Archives/edgar/data/1418819/000141881919000005/irdm_1231-2018x10k.htm.

beginning in 2017, Iridium began to deorbit its first-generation satellites on an individual basis. Iridium expects to complete the deorbit initiation process for all of its first-generation satellites during 2019.[3] All of these satellites will be deorbited via atmospheric re-entry in which each satellite's orbit is lowered, its fuel tanks are depleted, its batteries are drained, and its solar panels are angled for maximum atmospheric drag.

Iridium is an industry leader in orbital debris mitigation for a good reason. Although Iridium tracked its satellites and potential conjunction events, a decommissioned Russian satellite collided with one of Iridium's active first-generation satellites in 2009. Since then, Iridium has worked closely with the government as well as satellite operators to improve tracking of objects in space and prevent collisions. Iridium maintains close communication with the primary knowledge leader in the field of space debris, the U.S. Air Force Joint Space Operations Center ("JSpOC").[4] Through this partnership, we help to develop content and data for the space catalog, a public resource used to track all space debris. Additionally, our space operations team partners closely with JSpOC as well as other government and private entities to monitor and share our space traffic data, as well as help educate and influence other organizations on the importance of space situational awareness.

The launch of new satellite constellations offers significant promise for consumers and American space leadership. However, the increasing number of satellites expected in LEO will create significant space traffic management ("STM") and orbital debris mitigation challenges. To keep space free from clutter, preserve existing operations, and promote innovation in the space industry, the Commission must work with other U.S. government agencies and the space

[3] *Id.* at 19.

[4] Iridium, Space Sustainability, https://www.iridium.com/company-info/corporate-social-responsibility/sustainability/ (last visited Apr. 3, 2019).

industry to address issues related to STM and orbital debris mitigation. The NPRM is an important step in updating these rules to reflect the evolution and complexity of this process.

III. DISCUSSION

A. The Commission Should Adopt Standards to Promote Safe Flight Profiles in Low Earth Orbit

1. Applicants Should Be Required to Quantify Collision Risk

The Commission should require all applicants for non-geostationary orbit ("NGSO") satellites to quantify on-orbit collision risk. The Commission's proposal that a satellite capable of maneuvering should be treated as presenting "zero" risk of collision is unfounded[5] given that maneuvering capabilities have not ensured a collision risk of zero in the past. The Iridium 33 satellite had propulsion and conjunction risks were being tracked, but nevertheless it was unable to avoid the impact from the decommissioned Cosmos-2251. Instead of presuming a collision risk of zero for maneuverable satellites, the Commission should rely on quantitative analyses for assessing these risks.

2. Constellations Should Not Be Permitted to Overlap in Orbit

The FCC should require an applicant to identify the operational satellites to which the applicant's satellite(s) poses a collision risk, and indicate what steps have been or will be taken to coordinate operations. Applicants should be required to specify any and all other measures they intend to use to avoid collision.[6] To the extent that a proposed satellite system would pose an unreasonable collision risk to existing satellite constellations, the applicant should not be granted authority to launch and operate. As noted by Iridium and other satellite operators, "[o]perating more than one constellation in the same volume of space … dramatically

[5] NPRM ¶ 26.

[6] *Id.* ¶ 28.

increases operational complexity and elevates the risk of collision."[7] The Commission should impose this requirement on all NGSO systems, including NGSO's that operate beyond LEO such as HEO systems which could cross into LEO orbits.

In addition, the Commission should authorize only one NGSO satellite system to operate at a particular altitude. Phasing NGSO satellites within orbits to avoid collisions within the constellation of a single operator is incredibly complicated to do safely. It is even more complicated when an operator is forced to coordinate its movements with those of another operator in an overlapping orbit. This requirement should apply to satellites operating between 400 km and 2,000 km. This will ensure that finite orbital resources are used efficiently while limiting the risk of collision with operators in other orbital planes.

B. NGSO Satellites Must Be Reliably Designed and Held Accountable After an Event

As new operators design satellites that may not be as rigorously tested as those launched by Iridium or other incumbents, precautions must be taken in order to avoid failures in orbit that will threaten other systems. However, the Commission's proposed fabrication reliability standard of 0.999 per spacecraft is not the best way to achieve this goal.[8] It is difficult, if not impossible, to accurately assess reliability until the spacecraft is on orbit, which makes a requirement that satellites meet the 0.999 standard difficult to implement in practice. Instead, the Commission should require satellite applicants to provide sufficient technical and design information with their applications, consistent with existing Section 25.114(d)(14) and the rules adopted in this proceeding, for the Commission and other satellite operators to determine that

[7] Timothy Maclay, Walt Everetts & Doug Engelhardt, *Op-ed - Responsible satellite operations in the era of large constellations*, SpaceNews (Jan. 23, 2019) ("SpaceNews op-ed"), https://spacenews.com/op-ed-responsible-satellite-operations-in-the-era-of-large-constellations/.

[8] NPRM ¶ 43.

these designs will not fail and become a source of debris after they are launched.[9]

The Commission can further address spacecraft reliability by adopting notification and operational restrictions. The Commission should require all operators of space stations above 400 km to notify the Commission of any on-orbit satellite failures, whether such failures occur before or during operations.[10] Once an operator makes such a notification, the Commission should require the operator to identify and correct the root causes of the failure on the ground prior to launching any additional satellites. "A key risk of any new satellite development program is that undetected design or manufacturing problems could lead to premature failure in orbit."[11] To that end, satellite operators must be cautious not to deploy a constellation with a systemic flaw that could impact current and future satellite operations in LEO. Only when the cause of the failure has been determined and remedied should the operator be permitted to launch additional satellites. The Commission should require operators to file a notification certifying that the cause of the flaw has been identified and addressed before proceeding with additional launches.

C. The Commission Should Require Applicants Proposing NGSO Systems at Altitudes Above 400 km to Explain the Planned Operations and Control the Flight Paths of Their Assets

Instead of the proposed breakpoint of 650 km,[12] the Commission should instead use the 400 km altitude at its breakpoint for several key requirements of LEO satellite operations, including the requirement that applicants to justify their use of orbits above a certain altitude. Operators with spacecraft above 400 km have a responsibility to maintain control of their

[9] Comments of Iridium Communications Inc., IB Docket No. 18-251, at 14 (Sept. 7, 2018) ("Iridium Comments").

[10] *Id.*

[11] SpaceNews op-ed.

[12] NPRM ¶ 31.

spacecraft in the interest of protecting manned spaceflight and orbital altitudes in LEO that will only get increasingly crowded.[13] Requiring applicants seeking to operate between 400 km and 2,000 km to provide a rationale for the proposed orbit will help to ensure that unreasonable numbers of satellites are not launched to altitudes where they could interfere with the operations of the International Space Station ("ISS") and with other satellite operators. Applicants should be required to assess and address the existence of known sources of debris that is in or nearby to the proposed orbit,[14] and such discussion should include the applicant's plans for avoiding collision with the debris along with its rationale for choosing its operational orbit.

D. Satellites Operating Above 400 km Should Be Equipped with Propulsion and Be Capable of Being Maneuvered

The Commission should adopt its proposal that applicants describe the means of maneuverability of their spacecraft in the application.[15] Applicants planning to deploy NGSO spacecraft above 400 km have a responsibility to maintain custody and control of their spacecraft.[16] Propulsion is necessary for a space station to make effective collision avoidance maneuvers and any space station that reasonably poses a collision risk to the ISS should be able to perform such maneuvers. At a minimum, the Commission's proposal should refer to "propulsion" rather than "maneuverability." Non-propulsive methods of maneuvering satellites remain largely experimental and it is unclear whether they are capable of effectively reducing collision risk.

Satellites that lack propulsion systems have limited ability to avoid collision and to conduct end-of-life maneuvers. As a result, they pose a risk of harm to existing NGSO

[13] SpaceNews op-ed.

[14] NPRM ¶ 31.

[15] *Id.* ¶ 39.

[16] SpaceNews op-ed; Iridium Comments at 14.

networks. The Commission should adopt 400 km as the upper altitude at which space stations without propulsion should be permitted to operate. This altitude is sufficiently low to ensure that (a) non-maneuverable space stations will not pose a risk to the ISS, and (b) even in the event of a failure or collision, the satellite and its debris will naturally decay within a few years.[17]

E. NGSO Satellites Must Be Trackable and NGSO Operators Should Be Required to Maintain and Share Ephemeris Data

All satellites should be designed to be trackable from the ground either by active means – for example, through the use of laser retro-reflectors or radar-cross-section enhancements – or by ensuring they are sufficiently large to be discerned by common radar capabilities. It is Iridium's understanding that spacecraft larger than 10 cm in all directions can be tracked reliably by radar at the LEO altitudes based on the publicly stated capabilities of the JSpOC.[18]

Further, the Commission should adopt its proposal to require space stations to share information with the JSpOC or any successor space traffic management organization.[19] Space situational awareness capabilities are critical to maintaining a safe operating environment. It is in the best interest of all satellite operators that space stations are trackable and that location information is shared among operators.[20] As Iridium, OneWeb, and Maxar noted, "[i]t is also important for operators to share their position predictions and maneuvering plans with data aggregators and other stakeholders to support conjunction assessments, and for spacecraft to be equipped with effective maneuvering capabilities to respond to high-probability

[17] While the specific time it takes for an object to deorbit is based on several factors, including the cross sectional area and mass of the object, satellites at an altitude of 400 km and below typically reenter the atmosphere within a year.

[18] Comments of Iridium Communications Inc., IB Docket No. 18-86, at 7 (July 18, 2018) ("Iridium Small Satellite Comments").

[19] NPRM ¶ 37.

[20] Iridium Comments at 14.

conjunctions."[21] Iridium shares its ephemeris data and maneuvers with the Space Data Association and with the JSpOC and believes that cooperation with these institutions improves space situational awareness for all operators.

The Commission should also adopt its proposal to require operators to maintain and share ephemeris data with systems operating in the same region of space.[22] Iridium and other operators already share their ephemeris data and planned maneuvers with individual operators on an as needed basis. It is critical that operators share their data with operators in nearby orbits as it will help to ensure that operators make decisions related to satellite positioning based on the best situational awareness data available. By sharing information with stakeholders, NGSO operators will be better able to respond to high-probability conjunctions.[23]

F. The Commission Should Require Satellites to Be Disposed of Promptly and Reliably at the End of Their Missions

While the 25-year disposal guideline of the *NASA Standard* is a good benchmark, the Commission should require satellite operators to dispose of every spacecraft promptly and reliably at the end of its operational life. Specifically, the Commission should require LEO operators at altitudes below 2,000 km to deorbit satellites by atmospheric re-entry within a maximum of five years of the end of each satellite's operational life. Requiring deorbit should not impose a tremendous burden on operators as the additional cost to deorbit within 5 years rather than 25 is relatively minor and such measures will significantly improve the debris population in LEO.[24] The Commission should also consider requiring licensees to comply with a satellite disposal period that is "measured as a function of the design life of the licensed

[21] SpaceNews op-ed.

[22] NPRM ¶ 73.

[23] SpaceNews op-ed.

[24] *Id.*

[satellite] system"[25] to reflect that more satellites are being built with operational lives far shorter than the fifteen year term applied to most satellite operations in the FCC rules.[26] This would prevent satellites deployed for shorter periods of time from posing a debris risk long after they cease operations or longer than their operational lives. The Commission should hold operators of larger constellations to even more rigorous standards for deorbit because they can cause substantially more damage over extended periods of time.[27]

All spacecraft operating below 2,000 km should be deorbited by atmospheric re-entry.[28] This is the only way to ensure that the debris population is manageable in the long term. Atmospheric re-entry is the most effective and efficient way to control the debris population. Iridium has followed this practice and deorbited its first generation of satellites through atmospheric re-entry and will follow the same process when it is time to deorbit the Iridium NEXT satellites.[29] Consistent with the Commission's proposal, operators should not be permitted to place LEO satellites in higher disposal orbits at end-of-life where they will pose a debris risk for centuries or longer.[30]

For a relatively minor cost of mass, all satellites operating above 400 km in LEO should be equipped to be deorbited by propulsive means. This is a best practice for orbital stewardship. Space management policy must "put[] an end to 'passive satellites' that drift and are otherwise at

[25] Iridium Small Satellite Comments at 6-7; SpaceNews op-ed.

[26] 47 C.F.R. § 25.121.

[27] SpaceNews op-ed.

[28] NPRM ¶ 52.

[29] Iridium Constellation LLC, FCC File No. SAT-MOD-20131227-00148, Exhibit C at 7 (Dec. 27, 2013).

[30] NPRM ¶¶ 52-53.

the mercy of gravity, radiation, space weather and other phenomena."[31] Even during the deorbit phase, the only way to ensure that a satellite does not pose a risk as a piece of ballistic debris is to control the satellite all the way through atmospheric re-entry. Finally, while Iridium is encouraged by progress that has been made in direct retrieval technology, these technologies are still too nascent for the Commission to require or permit their use to facilitate deorbit. The question of whether direct retrieval would be an effective way to deorbit satellites is better left for a future rulemaking.

G. The Commission Should Adopt Requirements to Limit the Risk Deorbited Objects Pose to People or Property on Earth

The Commission should adopt its proposal that the human casualty risk assessment include all objects that would have an impacting kinetic energy in excess of 15 joules.[32] This proposal is consistent with the *NASA Standard* of limiting the risk of human casualty to at highest 1 in 10,000.[33] Satellites that are re-entering the earth's atmosphere upon end-of-life should be designed to demise upon re-entry and limit human casualty risk.[34] When the casualty risk is greater than zero, applicants should be required to provide a statement indicating the actual calculated human casualty risk as well as the input assumptions used in modelling re-entry.[35] Operators should be required to revisit the re-entry casualty risk annually on a system-wide basis.[36]

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[31] Matt Desch, *Space junk threatens our economic and national security. We need rules to head off chaos*., USA Today (May 14, 2018), https://www.usatoday.com/story/opinion/2018/05/14/space-junk-satellites-security-threat-trump-address-column/606030002.

[32] NPRM ¶¶ 60-61.

[33] *Id.*

[34] Iridium Comments at 15.

[35] NPRM ¶ 62.

[36] *See* SpaceNews op-ed.

IV. CONCLUSION

Iridium supports the Commission's efforts to revamp its orbital debris rules consistent with developments in the global space industry. The Commission should ensure that its new rules ensure the ongoing orbital integrity of LEO. To do so, NGSO satellite constellations should not be permitted to operate in overlapping orbits. The Commission should ensure that NGSO operators address the cause of satellite failure before they are permitted to launch additional satellites. Once in orbit, operators must track their satellites and share their satellite data with other operators in nearby orbits and the relevant governmental body. NGSO satellites operating between 400 km and 2,000 km should be deorbited via atmospheric re-entry no more than five years after the end of the satellite's operational life. Finally, when satellites are deorbited, operators must ensure that whatever remains will not pose a risk to satellites still in orbit or to people and property on Earth.

Respectfully submitted,

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