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

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

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April 5, 2019

SUMMARY

As a LEO satellite system owner with almost twenty-five years of experience operating a NVNG MSS constellation, ORBCOMM is acutely aware of the critical importance of orbital debris mitigation. ORBCOMM thus welcomes this Commission re-examination of its orbital debris Rules and policies, particularly in light of the significant changes that have occurred since the current Rules were adopted in 2004.

As the Commission recognizes, orbital debris is a negative externality – absent prudent continuing regulatory oversight, satellite system operators may be less likely to bear their equitable share of the costs of any orbital debris problems resulting from their operations. Thus, regulation to mitigate orbital debris has a potential part to play at various stages of the satellite system lifetime. And different regulators may play different roles at the various stages. As an initial matter, a regulator can assess an applicant's proposals to ensure that they have incorporated "best practices" into the system design. But once the systems move from the drawing board to implementation and the satellites are launched, then regulation has a role to play in space traffic management. Likewise, when satellites reach their end of life, then regulation has a role to play in the de-orbiting stage.

Notwithstanding the importance of effective space traffic management, however, it is not clear the extent to which the Commission has the authority, resources or expertise to play a prominent role in this essential activity. As the Commission recognizes, other Federal agencies are addressing the space traffic management issues. ORBCOMM urges the Commission to let these other agencies take the lead, with the Commission assuming a complementary role.

Orbital debris mitigation is clearly not an issue that the Commission, or the U.S, government, can solve unilaterally. As the Commission moves forward in this proceeding, ORBCOMM urges the Commission to continue to appropriately tailor its Rules and policies to synchronize to the greatest possible extent with the evolving roles and regulatory regimes that govern the plethora of other Federal agencies and Administrations elsewhere in the world that are engaged in efforts to administer orbital debris regulation.

The *Orbital Debris NPRM* addresses a wide range of issues. There are several proposals that ORBCOMM supports, and ORBCOMM believes that there should be consensus on many of these issues, including the proper regulations. In addition, for some of the proposals in the *Orbital Debris NPRM*, ORBCOMM anticipates that there will be a consensus on the goals, but ORBCOMM believes that the satellite system proponents should have greater flexibility in how those goals are achieved and/or that other measures should be taken to ensure that any resulting new regulation is practical, reasonable, and effective. Finally, for some of the proposals in the *Orbital Debris NPRM*, ORBCOMM believes that additional analyses will be necessary. In some cases, the proposals will need to be revised, and as a result, a further notice of proposed rulemaking would be appropriate.

ORBCOMM supports the proposal that applicants be required to quantify the probability of the collision risk consistent with the current NASA Standard, and to apply this on a constellation-wide basis. ORBCOMM also supports the proposals to clarify the responsibility of

an applicant in assessing collision risk, look to inter-system coordination in the first instance to address collision risk, and require all NGSO satellite system applicants to conduct these assessments. And while it is not clear that the Commission will have a primary role in space traffic management, ORBCOMM supports the proposals to require the applicants to specify in their applications the ability to track their satellites locations, and report information regarding initial deployment, ephemeris, and any planned maneuvers to the appropriate entities.

ORBCOMM believes other proposals should be modified. With regard to high-density orbits, ORBCOMM does not object to the Commission requiring assurances on how the applicant plans to reduce these risks, but ORBCOMM does not believe that an outright ban on proposed operations in these areas is the right approach. And rather than adopt the proposal to require propulsion above a certain altitude, ORBCOMM suggests that the Commission require "maneuverability" sufficient for collision avoidance and de-orbiting at the end of life. ORBCOMM likewise believes that the proposal to require two-stage deployment, with testing at the initial altitude before being raised to the target altitude is overly restrictive and unnecessary. And while the current 25-year de-orbit rule may merit revision, ORBCOMM also believes that satellite system operators need greater flexibility in the timing of de-orbiting than proposed by the Commission. Similarly, operators should be provided with some flexibility in how they prevent "hijacking" of their satellites.

The *Orbital Debris NPRM* identified issues with regard to multi-satellite deployments, but did not propose a solution. ORBCOMM believes that a Further NPRM to adopt fixes for this problem is necessary. ORBCOMM also believes a Further NPRM is necessary to address rights to particular orbits for NGSO systems, similar to the treatment of GSO slots at present. That proceeding can also address how much physical separation between different constellations is necessary.

ORBCOMM has concerns with the proposals for mandating de-orbiting reliability and requiring automatic de-orbiting after a satellite failure. These issues require further study. Finally, ORBCOMM has serious concerns with respect to two financial issues raised in the *Orbital Debris NPRM* – the proposals to address indemnification of the United States for any claims brought against the government as the launching/licensing Administration, and the imposition of a bond obligation that would be released upon successful de-orbiting. The costs that would be imposed by these proposals far exceeds any possible benefits that might be derived.

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COMMENTS OF ORBCOMM INC.

ORBCOMM Inc. ("ORBCOMM") hereby comments on the Commission's proposals to update its regulations with regard to orbital debris.[1] As a LEO satellite system owner with almost twenty-five years of experience operating a Non-Voice Non-Geostationary mobile satellite constellation (FCC Call Sign S2103), ORBCOMM is acutely aware of the critical importance of orbital debris mitigation. ORBCOMM thus welcomes this Commission re-examination of its orbital debris Rules and policies, particularly in light of the significant changes that have occurred since the current Rules were adopted in 2004.[2] Among other things, since that time, the Commission has issued many additional space segment authorizations for LEO satellite constellations comprised of hundreds or even thousands of spacecraft. And the last fifteen years has also seen the proliferation of a new class of very small satellites ("CubeSats") that are being

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1 *Mitigation of Orbital Debris in the New Space Age*, FCC 18-159, released November 19, 2018, 84 Fed Reg 4742 (February 19, 2019) (hereafter cited as "*Orbital Debris NPRM*").

2 *Mitigation of Orbital Debris*, Second Report and Order, 19 FCC Rcd 11567 (2004).

launched by experienced and inexperienced operators.[3] The Commission, working with other Federal agencies, must continue to take all practical and reasonable measures to ensure that the valuable resource of outer space does not become irredeemably "polluted" by orbital debris.

I. The Role of the Commission

The Commission recognizes that the New Space Age greatly complicates the ability to mitigate orbital debris, while at the same time enhancing the criticality of orbital debris mitigation. Advances in small satellite technologies and new launch options are greatly reducing costs while increasing capabilities, which in turn is leading to a proliferation of CubeSats being launched into LEO. The small size of these satellites can make tracking them quite difficult. Moreover, many of these CubeSats have limited active maneuvering capability. In addition, since many of the parties deploying CubeSats often rely exclusively on opportunistic launches as a secondary payload, CubeSat operators have limited ability to choose a particular orbit, because the orbital insertion for their satellites launched as secondary payloads depends on the altitude and inclination of the primary payload. Finally, applicants have proposed constellations comprised of hundreds and even more CubeSats. As a result, space traffic management becomes increasingly complicated by these CubeSats.

Another phenomenon of the New Space Age is the proposed launch of LEO mega-constellations comprised of hundreds, and in some cases thousands of satellites to provide ubiquitous, global broadband service. While the proposed satellites in these types of mega-constellations are not nearly as large as some of the current geostationary satellites,[4] they are

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[3] *Streamlining Licensing Procedures for Small Satellites, Notice of Proposed Rulemaking*, IB Docket No. 18-86, 33 FCC Rcd 4152 (April 17, 2018).

[4] Indeed, the new ViaSat high-powered GEO satellite, with the extension of the and solar arrays, has a span of 158 feet (48 meters), wider than the wingspan of a Boeing 737 jet.

significantly larger than the CubeSats that are being launched today. By way of example, some of these mega-constellation satellites are on the order of 150 kg in mass, and approximately the size of a washing machine,[5] whereas CubeSats are typically not much larger than a toaster, and in some cases not even larger than a piece of toast. Taken together, the growing proliferation of CubeSats, opportunistic secondary payload launches, and mega-constellations has significantly increased the challenges involved with mitigating orbital debris.

In light of these significant changes, the Commission's orbital debris mitigation Rules and policies clearly merit re-examination and revision.[6] Moreover, ORBCOMM believes that the Commission *and* the satellite industry cannot rely on marketplace forces alone to address orbital debris issues in this much more complicated environment of the New Space Age. As the Commission recognizes,[7] orbital debris is a negative externality – absent prudent continuing regulatory oversight, satellite system operators may be less likely to bear their equitable share of the costs of any orbital debris problems resulting from their operations. In the case of an on-orbit collision or other debris-causing event, the results can clearly adversely affect other satellite system operators.

Given the difficult calculus of economic trade-offs inherent to minimizing the risk of orbital debris, practical and reasonable regulatory intervention is well-merited. This is not just a theoretical concern for the Commission's new Office of Economics and Analytics to ponder.

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5 *See, e.g.*, https://www.upi.com/amp/Top_News/US/2019/03/19/OneWeb-starts-to-mass-produce-satellites-in-Florida/6221553010025/.

6 *Orbital Debris NPRM*, at ¶ 6.

7 *Orbital Debris NPRM*, at ¶¶ 81 and 89.

Of course, identifying any need for regulatory oversight or revisions to an existing regulatory regime always raises important issues with regard to the nature of any such regulation or regulatory modification, and which agency or agencies should develop and enforce any necessary regulations. Moreover, whichever regulatory agency addresses the orbital debris issues must also ensure that any regulations do not impose any unnecessary or excessive costs, and do not stifle technical innovation or otherwise needlessly constrain satellite and constellation designs.

Regulation to mitigate orbital debris has a potential part to play at various stages of the satellite system lifetime. And different regulators may play different roles at the various stages. As an initial matter, a regulator can assess an applicant's proposals to ensure that they have incorporated "best practices" into the system design, including the features and capabilities of the spacecraft, as well as the constellation – the altitude, number of planes, inclination (s) and number of satellites. The Commission does that now by reviewing the applicant's debris mitigation plan, as well as requiring modeling of the risks of orbital debris.

But once the systems move from the drawing board to implementation and the satellites are launched, then regulation has a role to play in space traffic management. Likewise, when satellites reach their end of life (through normal aging or malfunction), then regulation has a role to play in the de-orbiting stage, so as to minimize the risk of "dead" satellites posing increased collision risk. Successful space traffic management, including monitoring and active collision avoidance is critical, particularly because the initial review at the application stage involves modeling and forecasting, which may not be reliable for a variety of reasons. For example, the currently available modeling tools may not accurately assess the collision risks for CubeSats and

other smaller satellites.[8] And even with the best modeling efforts prior to deployment, for various reasons, satellites may not actually be inserted to the orbits that are used for debris mitigation modeling. Or, as ORBCOMM discovered when reviewing the modeling performed in connection with Spaceflight's initial planned Sherpa mission, debris mitigation modeling might sometimes be "gamed" by assuming the satellites will be disbursed randomly.[9] Given that there would be an almost infinite permutation of possible configurations by using random dispersal as the input for the model, the calculated "risk of collision" becomes infinitesimally small, even though the risk of an orbital collision of the actual deployment is never assessed.

More so than debris mitigation modeling, responsible design, fabrication, and on-ground pre-flight testing are critical to minimizing orbital debris. Similarly, properly orchestrated techniques and procedures for active collision avoidance as an element of space traffic management are critically essential for dealing with the actual operational environment in space.[10] Notwithstanding the importance of effective space traffic management, however, it is not clear the extent to which the Commission has the authority, resources or expertise to play a prominent role in this essential debris mitigation activity. As the Commission recognizes, other Federal agencies are addressing the space traffic management issues.[11] ORBCOMM urges the

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8 *See, e.g.*, Comments of Space Exploration Holdings, LLC on the Application of Swarm Technologies, Inc., File No. SAT-LOA-20181221-00094, filed April 1, 2019.

9 Letter from Counsel for ORBCOMM to Marlene H. Dortch, File Nos. SAT-MOD-20150802-00053; SAT-LOA-20151123-00078; SAT-STA-20150821-00060, dated August 9, 2016.

10 *Orbital Debris NPRM*, at ¶ 96.

11 *Orbital Debris NPRM*, at ¶¶ 12-13 and 98.

Commission to let these other agencies take the lead, with the Commission assuming a complementary role.

Finally, ORBCOMM observes that orbital debris mitigation is a global issue for all types of satellites, but particularly for NGSO constellations, because the constellations operate globally, and other Administrations authorize NGSO satellite systems. This is not an issue that the Commission, or the U.S, government, can solve unilaterally. As the Commission moves forward in this proceeding, ORBCOMM urges the Commission to continue to appropriately tailor its Rules and policies to synchronize to the greatest possible extent with the evolving roles and regulatory regimes that govern the plethora of other Federal agencies and Administrations elsewhere in the world that are engaged in efforts to administer orbital debris regulation.

As discussed below, it seems very clear that several of the Rule and policy proposals in the *Orbital Debris NPRM* require additional analyses and consideration in a further notice of proposed rulemaking in order to get the regulations right, or perhaps not adopt some of the proposed regulations at all. Given the importance of the satellite industry and the criticality of mitigating orbital debris and preserving future access to the invaluable yet fragile orbit resource, the key is to get it done right, not simply get it done quickly.

II. To the Extent the Commission Moves Forward on These Issues, ORBCOMM Offers Comments on Some of the Particular Proposals

The *Orbital Debris NPRM* addresses a wide range of issues. There are several proposals that ORBCOMM supports, and ORBCOMM believes that there should be consensus on many of these issues, including the proper regulations. In addition, for some of the proposals in the *Orbital Debris NPRM*, ORBCOMM anticipates that there will be a consensus on the goals, but ORBCOMM believes that the satellite system proponents should have greater flexibility in how

those goals are achieved and/or that other measures should be taken to ensure that any resulting new regulation is practical, reasonable, and effective. Finally, for some of the proposals in the *Orbital Debris NPRM,* ORBCOMM believes that additional analyses will be necessary. In some cases, the proposals will need to be revised, and as a result, a further notice of proposed rulemaking ("*FNPRM*") would be appropriate. ORBCOMM addresses these three different categories of proposals below.

A. Proposals that ORBCOMM Supports

The Commission's Rules currently requires applicants to conduct a collision risk assessment with large objects, but does not specify the details of that assessment.[12] The *Orbital Debris NPRM* proposes that applicants be required to quantify the probability of the collision risk consistent with the current NASA Standard.[13] The Commission also proposes to adopt the NASA Standard specification of a 0.001 maximum collision risk metric, but to apply this on a constellation-wide basis, not merely a per satellite basis. Although the limits of any attempts to model collision risk with a truly dispositive degree of accuracy must be recognized, modeling unquestionably does serve as a necessary means of identifying potentially risky proposals. And it makes sense to enhance the uniformity and accuracy of Commission-mandated collision risk assessments by tying them to the applicable NASA Standards and analytical software tools as they continue to evolve. Accordingly, ORBCOMM supports this proposal, with the Commission's modification that the metric be applied on a system-wide basis. An applicant is

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[12] 47 CFR § 25.114(d)(14)(iii). Although the Commission did not specify the details for the assessment methodology in the Rules, they did refer to NASA standards as generally sufficient. *See Guidance on Obtaining Licenses for Small Satellites,* Public Notice, 28 FCC Rcd 2555, 2558 (IB/OET 2013).

[13] *Orbital Debris NPRM,* at ¶ 26.

seeking authority to launch a constellation of satellites, and the cumulative risk of that constellation is what is relevant to the Commission's determination of whether the proposal may be too risky to issue a license.

The *Orbital Debris NPRM* proposes additional changes to the orbital debris risk assessment rule to clarify the responsibility of an applicant in assessing collision risk, look to inter-system coordination in the first instance to address collision risk, and require all NGSO satellite system applicants to conduct these assessments (not just LEO systems).[14] ORBCOMM agrees that these proposed refinements will provide greater certainty to both new applicants and incumbent operators, without unduly burdening them. ORBCOMM thus supports these proposals.

As discussed above, space traffic management is a critical component of orbital debris mitigation. And while the Commission's role in space traffic management is presently unclear, ORBCOMM does support the *Orbital Debris NPRM* proposals that would facilitate space traffic management, even if the actual management is handled by other agencies. Paragraphs 36-38 of the *Orbital Debris NPRM* address requiring the applicants to specify in their applications the ability to track their satellites locations, and report information regarding initial deployment, ephemeris, and any planned maneuvers to the 18th Space Control Squadron or any successor thereof duly appointed by the U.S. Government pursuant to applicable law. The applicants would also have to certify that upon receipt of a conjunction warning, they will take all possible steps to assess and, if necessary, to mitigate collision risk. ORBCOMM supports this proposal as a step the Commission can take to help ensure that licensees will have the ability to fully participate in the space traffic management scheme ultimately adopted by the U.S. government.

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[14] *Orbital Debris NPRM*, at ¶ 28.

The *Orbital Debris NPRM* also proposes to modify the Commission's Rules for amateur and experimental satellite operations to conform to changes adopted in this proceeding.[15] ORBCOMM supports this proposal. While presumably the number of satellites subject to such licensing will be smaller than commercial constellations, there is no reason to exempt those satellites from the same analyses and review. The adverse effects of a collision will be identical, regardless of the non-commercial nature of the satellite licensee.

In addition to proposed revisions to the satellite application process, the *Orbital Debris NPRM* also proposes some changes to the rules to address satellite operations. The Commission proposes to require telemetry, tracking, and command operations to be coordinated between satellite operators as necessary to avoid interference events during orbit raising maneuvers, rather than simply require that such operations be done on a non-interference basis.[16] ORBCOMM supports this proposal. It provides satellite system operators with greater flexibility, and the interference issues are clearly within the Commission's authority and expertise.

B. Proposals That Should be Modified to Allow Greater Flexibility

With regard to some of the proposals in the *Orbital Debris NPRM*, ORBCOMM agrees with the goal the Commission is trying to achieve, but believes that the public interest would be better served by providing satellite system operators with greater flexibility in achieving that goal than the specific rule proposed by the Commission. Indeed, the Commission itself acknowledges that:

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[15] *Orbital Debris NPRM,* at ¶¶ 82-83.

[16] *Orbital Debris NPRM,* at ¶ 71.

> Further, we are cognizant that technology continues to develop rapidly in the satellite design arena and seek to avoid potential requirements that may wed designers to a current conception of technological limits that could be changed in the future.[17]

ORBCOMM thus urges the Commission to revise the following proposals in the *Orbital Debris NPRM* that might unnecessarily constrain the satellite system or impose unnecessary costs.

The *Orbital Debris NPRM* suggests that it may be in the public interest for satellite system applicants to avoid deployment into areas where debris is particularly dense, such as areas where there is a debris cloud from a previous collision.[18] ORBCOMM does not believe that an outright ban on such deployments is necessary. Such a limit could become outdated as an orbital debris cloud dissipates or orbital debris tracking and avoidance, or even debris capture and disposal techniques continue to evolve. But an applicant should be aware of the increased risks of an orbital debris collision in areas of high density, assuming that the model used to assess collision risk accurately accounts for the higher density. And an applicant will need to address instances of higher collision risk, regardless of whether it results from proposed operations in a higher-density area, operations involving mega-constellations, or other exacerbating factors. ORBCOMM does not object to the Commission requiring assurances on how the applicant plans to reduce these risks, but ORBCOMM does not believe that an outright ban on proposed operations in high-density areas would serve the public interest.

The *Orbital Debris NPRM* also seeks comment on whether to require all satellites operating above a certain (as yet undefined) altitude to include propulsion capabilities reserved

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[17] *Orbital Debris NPRM*, at ¶ 43.

[18] *Orbital Debris NPRM*, at ¶ 33.

for station-keeping and to enable collision avoidance maneuvers.[19] Elsewhere in the proposed rules, the Commission suggests that an altitude above 650 km should draw extra scrutiny. ORBCOMM appreciates the goal of requiring de-orbiting and collision-avoidance capabilities above 650 km, because of the longer period of time it would take for natural decay after the satellite's end-of-life, thus posing greater risks of orbital collisions. And in the case of any collisions at higher LEO altitudes, the debris cloud would also persist for much longer (and in some higher altitude orbit instances *far longer)* than at altitudes below 650 km. But rather than mandate "propulsion," ORBCOMM suggests that the Commission require "maneuverability" sufficient for collision avoidance and de-orbiting at the end of life. Such a change would provide satellite system operators with the flexibility to utilize other potential technologies that could accomplish the same goals.

The *Orbital Debris NPRM* proposes several rules to address minimization of a satellite's time on-orbit after it is no longer providing service.[20] As a general principle, ORBCOMM acknowledges the public interest benefits from minimizing the time that a "dead" satellite is on-orbit, because such satellites pose a risk of collision, without providing any offsetting benefits in terms of the services they can offer. Thus, ORBCOMM supports the Commission's proposal for reviewing the post-mission disposal reliability of the system, and believes that the suggested guideline of 0.99 for post-mission disposal reliability may be appropriate. However, ORBCOMM is concerned that the costs are quite likely to exceed any possible benefit that may be derived by adoption of the specific proposal that a satellite system operator be required to

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[19] *Orbital Debris NPRM*, at ¶ 34. *But, cf., Orbital Debris NPRM*, at ¶ 39 ("We seek comment on this conclusion and note that, as proposed, this is an informational requirement, and would not require that all satellites have propulsion or maneuverability.").

[20] *Orbital Debris NPRM*, at ¶¶ 46-57.

conduct on-orbit testing for satellites that will be deployed above 650 km at a lower altitude, and raised to the operational altitude only after the satellites have been evaluated for proper operation at the lower altitude. Imposing this new mandatory requirement may very well not provide any material increased assurance of spacecraft functionality over the life of a spacecraft. Among other things, satellite system failures can and do occur at any time, regardless of the diligence put forth to properly design, fabricate, test, and operate a spacecraft. Most assuredly, however, although the benefits are questionable and virtually impossible to accurately quantify, imposing this new mandatory post-testing maneuvering requirement would impose significant unrecoverable cost burdens on satellite operators. Satellite manufacturers and operators should be strongly encouraged to follow long-established industry quality and reliability practices by rigorously testing spacecraft and spacecraft systems on the ground during the fabrication process and prior to launch. Satellite operators should also be encouraged, but not required by new compulsory regulation, to follow long-established industry practices for pre-operational on-orbit testing. But the costs definitely appear to exceed any benefit that might be derived from imposing a mandatory two-stage initial deployment requirement.

The *Orbital Debris NPRM* seeks comment on whether the current 25-year standard for post-mission atmospheric entry is too long.[21] ORBCOMM agrees that in light of the expected growth in the number of satellites that will be operating in LEO in the New Space Age, the current 25-year standard may be too long under certain circumstances. However, ORBCOMM believes it may be premature to select a specific shorter time period. Moreover, what would be a "reasonable" amount of time would vary with the level of risk proposed, which will depend on a number of factors. A hard and fast limit fails to account for these differences. At a minimum,

[21] *Orbital Debris NPRM*, at ¶ 59.

any new policy that alters the current 25-year de-orbit standard that is adopted by the Commission should provide sufficient flexibility for a licensee to extend mission lifetime for satellites that remain capable of commercial operation for periods beyond their original design life.[22]

The *Orbital Debris NPRM* also includes a proposal to require satellite system operators to share satellite ephemeris data with any other operator identified in its disclosure described above of any operational space stations that may pose a collision risk.[23] The *Orbital Debris NPRM* also suggests that to allow flexibility, such sharing could be "by means mutually acceptable to the parties involved." ORBCOMM suggests that the Commission clarify that the data sharing could occur by a satellite system operator providing the ephemeris data to a third-party that the other affected operators could access, such as an industry-sponsored consortium, in order to avoid the inefficiency of having to send the data to multiple parties.

The *Orbital Debris NPRM* identifies the potential problem of a malfeasor "hi-jacking" a satellite and using their control over that satellite to cause a collision or harmful interference.[24] To address this concern, the Commission proposes to require that a satellite system operator encrypt its telemetry, tracking, and command ("TT&C) communications. ORBCOMM agrees that this is a legitimate concern, but suggests that satellite system operators be provided with the flexibility to demonstrate that it will incorporate "anti-hijacking safeguards" other than encryption of the TT&C communications if they can demonstrate that such alternative measures will be adequate.

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22 *Orbital Debris NPRM*, at ¶ 32.

23 *Orbital Debris NPRM*, at ¶ 73.

24 *Orbital Debris NPRM*, at ¶ 75.

C. Proposals that Require Further Study and/or Merit Consideration in a Further Notice of Proposed Rulemaking

ORBCOMM believes that it would be premature to adopt some of the proposals in the *Orbital Debris NPRM*, because the record is insufficient to support the proposed regulation, and additional information is needed for an informed analysis of the effectiveness and impact of such regulations. In some instances, the Commission would need to issue an *FNPRM* in order to provide commenters with an opportunity to address specific new proposals.

The *Orbital Debris NPRM* raises an issue with regard to multi-satellite deployments.[25] ORBCOMM encountered such a problematic situation, and believes that the Commission (or perhaps some other Federal agency) should adopt a regulation to address this concern. ORBCOMM had raised questions about two proposed satellite system applications that included orbits that overlapped with ORBCOMM's constellation.[26] ORBCOMM then learned that these two applicants were planning on a launch as a secondary payload as part of a multi-satellite launch that was going to deploy a total of at least 90 satellites from multiple system operators.[27] ORBCOMM's concern with regard to this overlapping deployment was heightened because the satellites to be deployed on the multi-satellite launch mission were of various designs, size, and mass, and were to be injected on orbit using a vaguely described highly random deployment plan. Moreover, the manager of that mission disclaimed any responsibility for assessing the risk of a collision between the 90 satellites and ORBCOMM's constellation, or the risk of a collision

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[25] *Orbital Debris NPRM*, at ¶¶ 20 and 40.

[26] Application of Planet Labs Inc., File No. SAT-MOD-20150802-00053; Application of Spire Global, Inc., File No. SAT-LOA-20151123-00078.

[27] Application of Spaceflight, Inc., Request for Special Temporary Authority, File No. SAT-STA-20150821-00060.

amongst the 90 satellites, which in turn could create a debris cloud that would adversely affect ORBCOMM. The mission manager asserted that any such analyses was the satellite licensees' responsibility – maintaining that it was only responsible for assessing the collision risk of its multi-satellite deployment vehicle.[28] However, the individual licensees lacked information on the mission as a whole, so themselves could not reasonably and accurately conduct the analyses.[29]

While the *Orbital Debris NPRM* recognizes this problem, ORBCOMM believes that there needs to be a solution so this situation does not recur. The Commission must ensure that responsibility is assigned to one (or more) of the parties to formulate deployment plans that minimize the risk of intra-mission collisions, as well as the risks of a collision between the mission as a whole and any other potentially affected satellite systems. In the case of these types of launch missions involving multiple spacecraft of varying design, "best practices" would certainly seem to point to the multi-satellite consolidator/mission operator as the best situated party to bear this responsibility. This is because the mission operator in this situation is clearly the best situated party with respect to the entire consolidated launch mission to assess the risk of both intra-mission collisions and collisions with other space objects, and provide a pre-mission deployment plan that can be assessed by spacecraft operators with existing satellites in affected orbits. However, although there is clearly a need to establish debris mitigation policies that place

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[28] Letter from Counsel for Spaceflight to Marlene H. Dortch, File No. SAT-STA-20150821-00060, dated May 13, 2016. The regulatory situation was further complicated in that case by the fact that the 90 satellites were licensed by a total of ten different countries (United States, Brazil, Chile, Finland, France, Slovak Republic, South Korea, Spain, Switzerland and UAE), which also highlights the global nature of orbital debris issues.

[29] Moreover, as discussed above, any modeling was skewed by the proposal to disperse the satellites randomly. *See* n. 9, *supra*.

appropriate compliance obligations on small satellite launch mission consolidators, any such policies that are adopted should not relieve the individual spacecraft operators that utilize these types of launches from meeting their own debris mitigation compliance responsibilities.[30] New Commission Rules and policies to address debris mitigation by multi-satellite launch aggregators and the satellite operators that utilize these types of launches clearly appear to be merited, and are ripe for consideration in an *FNPRM* in this proceeding.

The issue of operational altitude selection arises in the *Orbital Debris NPRM* in a couple of different contexts. The Commission raises the issue directly in discussing how an applicant should address altitude selection in its application.[31] In addition, altitude selection is implicated in the *Orbital Debris NPRM* when discussing maximum altitude variance.[32] In the GSO context, the Commission has well-defined regulations with regard to orbital positions. The rules are designed to assign specific frequency rights at specific orbital locations, with the satellites spaced 2 degrees apart (with wider spacing for MSS and BSS satellites). In addition, the Commission has clearly defined rules and procedures for assignments of GSO orbital positions.[33] And importantly, there is a clearly defined set of procedures and regulations for international priorities for GSO orbital slots through the ITU.

But the same is not true for NGSO systems. And with the advent of the New Space Age, the operational availability of NGSO orbits appears likely to become an increasingly scarce

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30 Presumably as a customer on the multi-satellite launch, the applicant should have sufficient leverage to obtain the necessary information from the multi-satellite manager to conduct the analyses.

31 *Orbital Debris NPRM,* at ¶ 33.

32 *Orbital Debris NPRM,* at ¶ 35.

33 47 C.F.R. §25.158.

resource. Evolving space traffic management policies and practices clearly should address issues such as how much physical separation is necessary, and how to assign orbits if there is contention amongst multiple systems for the same (or similar) altitudes and/or inclinations. Given the uncertainty as to both domestic and international issues of space traffic management, including which agencies have jurisdiction, expertise and authority, ORBCOMM believes it is premature for the Commission to try to set rules on maximum altitude variance and orbit selections. Hopefully the record developed on these issues in the current comment cycle will provide useful guidance for the Commission's further consideration of these matters in an *FNPRM*.

ORBCOMM also has significant concerns with the *Orbital Debris NPRM* proposals on design reliability, disposal reliability and automatic de-orbiting of a satellite upon failure.[34] It seems quite clear that the Commission does not have a sufficient foundation at this time to adopt specific regulations establishing any new hard requirements regarding these three subject matter areas. As the Commission acknowledges with regard to design reliability: "we are cognizant that technology continues to develop rapidly in the satellite design arena and seek to avoid potential requirements that may wed designers to a current conception of technological limits that could be changed in the future."[35] With respect to disposal reliability, the *Orbital Debris NPRM* cites a NASA study which concluded "that a 0.99 spacecraft post-mission disposal reliability is needed to mitigate the serious long-term debris generation potential" for large constellations.[36] But it is not clear the extent to which the forecasts in the reliability predictions

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[34] *Orbital Debris NPRM*, at ¶¶ 43, 46 and 48.

[35] *Orbital Debris NPRM*, at ¶ 43.

[36] *Orbital Debris NPRM*, at ¶ 46.

for the New Space Age constellations will map with reality, or where the line should be drawn between the current NASA standard of 0.90 and the 0.99 that the NASA study concluded was needed.

It also appears quite clear that the Commission needs more information before it can adopt a requirement for automatic de-orbiting upon a failure. It has been ORBCOMM's experience that, in many cases, where there has been an on-orbit ORBCOMM spacecraft failure, it has been possible to revive the satellite and return it to commercial service. And ORBCOMM is not alone in this regard – accounts of satellite operators recovering spacecraft following failures are not at all uncommon. Setting a trigger for automatic de-orbiting too soon after a failure could result in taking spacecraft out of service that could very well have been restored. Furthermore, it is not at all clear that a reasonable universal standard can be devised for determining the appropriate trigger event for automatic de-orbiting, or that such capabilities could be reliably incorporated in spacecraft designs to activate following a failure that permanently removes the satellite from service. A further examination of this concept in an *FNPRM* certainly appears necessary to allow the Commission to collect information on other satellite system operators' experience with restoration of "failed" satellites to determine if it is useful, practical, or feasible to consider automatic de-orbit regulation.

Finally, ORBCOMM has substantive concerns with respect to two financial issues raised in the *Orbital Debris NPRM* – (i) the proposal to address indemnification of the United States for any claims brought against the government under international law as the licensing/launching Administration; [37] and (ii) the imposition of a bond obligation that would be released upon

[37] *Orbital Debris NPRM,* at ¶¶ 78-80 and 95.

successful de-orbiting.[38] With respect to indemnification, it is not clear whether it will be possible for satellite system operators to obtain insurance at reasonable rates. And without insurance to fund an indemnification liability, it is very likely that defaults on such obligations could easily occur, rendering such a requirement ineffective and unenforceable. The on-orbit liability is based on a fault regime, but it is far from clear how fault can be assigned in the case of a collision. Re-entry liability is assessed based on a strict liability regime, but the re-entry is unlikely to occur for many years, which could make the setting of insurance rates somewhat arbitrary. In addition, rather than proposing a standardized indemnification agreement or licensing condition, the *Orbital Debris NPRM* instead indicates that the Commission might work with other agencies "to establish the parameters of such an agreement, including the scope of the indemnification."[39] The Commission goes on to propose that an agreement be "completed" within 30-days after grant of a license, which suggests that such agreements may be the subject of individual negotiation. But the lack of uniformity that would be inherent to such an approach is likely to have various negative repercussions that would be contrary to the public interest. For all of these reasons, it does not appear that there is a sufficient basis for any decision regarding the proposed new indemnification requirement that will result from the *Orbital Debris NPRM*. Accordingly, if this matter is to be further considered, it would be best dealt with in an *FNPRM*.

The concept of requiring satellite licensees to obtain and maintain a performance bond to be released upon successful de-orbiting may theoretically appear to some to be a possible means to compel better debris mitigation practices. However, the near certain adverse consequences of

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[38] *Orbital Debris NPRM*, at ¶ 81.

[39] *Orbital Debris NPRM*, at ¶ 78.

implementing and complying with such a requirement appear likely to negate any positive benefits that might be derived. Experience with satellite licensee performance bonds required thus far by the Commission unquestionably indicates that the monetary cost of maintaining de-orbit bonds are likely to be extremely high. In most cases, significant capital will be tied up for a long period of time, because typically the bond companies require funds to cover the bond to be kept in escrow. And on top of that, the bond company typically charges a not insignificant annual fee. If the satellite is successfully de-orbited, then the opportunity cost of the escrowed funds and the fees charged by the bond company will have been spent needlessly. On the other hand, if the satellite is not successfully de-orbited and the bond is forfeited, the satellite remains on-orbit with its increased risk of a collision.

Although the concept of retrieving space junk has captured some attention and even some preliminary investment and R&D, it is not clear if the Commission could ever establish a program to use forfeited de-orbit bonds to pay for the retrieval of spacecraft that were not successfully de-orbited. But without such a retrieval program, the proposed bond would penalize successful operators, penalize unsuccessful operators more harshly, but not solve the problems created by the unsuccessful operators. Accordingly, there does not appear to be any clear public interest benefit the would result from the Commission adopting the bond proposal set forth in the *Orbital Debris NPRM*.

III. Conclusion

ORBCOMM welcomes the Commission's efforts to update its orbital debris mitigation rules in light of the significant changes occurring in the satellite industry presently. The Commission must continue to ensure that it harmonizes its actions with those of the other Federal agencies and foreign Administrations that oversee orbital debris mitigation and space

traffic management. As explained in these comments, ORBCOMM believes that some of the Commission's proposals in the *Orbital Debris NPRM* should be adopted, some should be modified to provide applicants with greater flexibility, and some should be deferred pending additional information and/or an *FNPRM*. Such courses of action will best serve the public interest.

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April 5, 2019