

**Before the  
Federal Communications Commission  
Washington, D.C. 20554**

In the Matter of	)	
	)	
Space Exploration Holdings, LLC	)	IBFS File No. SAT-LOA-20170301-00027
	)	
Application for Approval for Orbital Deployment and Operating Authority for the SpaceX V-band NGSO Satellite System	)	Call Sign S2992

**MEMORANDUM OPINION, ORDER AND AUTHORIZATION**

**Adopted: November 15, 2018**

**Released: November 19, 2018**

By the Commission: Chairman Pai and Commissioners O’Rielly, Carr, and Rosenworcel issuing separate statements.

**I. INTRODUCTION**

1. In this Memorandum Opinion, Order and Authorization, we grant the application of Space Exploration Holdings, LLC (SpaceX)<sup>1</sup> to construct, deploy and operate a proposed non-geostationary orbit (NGSO) satellite system using frequencies in the V-band.<sup>2</sup> We defer action, however, on SpaceX’s request to use the 50.4-51.4 GHz band for service and gateway uplinks. In granting this application, we address concerns expressed by commenters seeking various conditions on the grant. SpaceX’s V-band operations will augment the capabilities of SpaceX’s Ku-band and Ka-band NGSO system that was recently authorized.<sup>3</sup> Grant of this application will enable SpaceX to provide both diverse geographic coverage and the capacity to support a wide range of broadband and communications services for residential, commercial, institutional, governmental and professional users in the United States and globally.<sup>4</sup>

**II. BACKGROUND**

2. *Application.* On March 1, 2017, SpaceX filed an application for a proposed NGSO fixed-satellite service (FSS) satellite system in the V-band.<sup>5</sup> The proposed SpaceX system consists of the

<sup>1</sup> *Space Exploration Holdings, LLC, Application for Approval for Orbital Deployment and Operating Authority for the SpaceX V-band NGSO Satellite System*, IBFS File No. SAT-LOA-20170301-00027 (filed March 1, 2017) (SpaceX V-band Application).

<sup>2</sup> For purposes of this Memorandum Opinion, Order and Authorization, we use the term “V-band” to refer to frequencies ranging from 37.5 GHz to 52.4 GHz. As noted below, the request by SpaceX for authority in the 42.0-42.5 GHz and 51.4-52.4 GHz frequency bands is not before us, because there is no domestic allocation for satellite services in 42.0-42.5 GHz band and there is no domestic or international allocation for satellite services in the 51.4-52.4 GHz frequency band.

<sup>3</sup> *Space Exploration Holdings, LLC, Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System*, Memorandum Opinion, Order and Authorization, FCC 18-38 (Mar. 29, 2018) (*SpaceX Ku/Ka-band Order*).

<sup>4</sup> SpaceX V-band Application, Narrative at 2.

<sup>5</sup> SpaceX filed this application in response to an International Bureau public notice that initiated a “processing round” for additional NGSO applications in the 37.5-40.0 GHz, 40-42 GHz, 47.2-50.2 GHz and 50.4-51.4 GHz frequency bands. *Boeing Application Accepted for Filing in Part, IBFS File No. SAT-LOA-20160622-00058; Cut-off Established for Additional NGSO-Like Satellite Applications or Petitions for Operations in the 37.5-40.0 GHz,*

addition of V-band frequencies to the 4,425 NGSO satellites previously authorized to allow the use of both Ku- and V-band spectrum for user links, and both Ka- and V-band spectrum for gateway links and tracking, telemetry, and command functions. SpaceX also proposes to add a very-low-Earth orbit (VLEO) NGSO constellation, consisting of 7,518 satellites operating at altitudes from 335 km to 346 km, using V-band spectrum for all links to and from associated earth stations. The V-band frequencies proposed are: 37.5-42.0 GHz (space-to-Earth), and 47.2-50.2 GHz, and 50.4-51.4 GHz (Earth-to-space).<sup>6</sup> In its application, SpaceX sought certain waivers of the Commission's rules.<sup>7</sup>

3. *Comments.* On August 25, 2017, the SpaceX application to operate in the 37.5-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz frequency bands was accepted for filing.<sup>8</sup> Several satellite operators filed comments in response to the SpaceX application.<sup>9</sup> SpaceX filed a response to these comments.<sup>10</sup> ViaSat and SES and O3b also filed reply comments.<sup>11</sup>

4. *Developments Subsequent to SpaceX Application.* In September 2017, following the close of the comment cycle in this proceeding, the Commission adopted the *NGSO FSS Report and Order*, updating several rules and policies governing NGSO FSS systems.<sup>12</sup> The Order adopted, among other things, spectrum sharing rules and a more flexible milestone schedule for NGSO systems.<sup>13</sup> In

(Continued from previous page)

40.0-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz Bands, Public Notice, 31 FCC Rcd 11957 (IB 2016) (*Boeing Application Public Notice*). The International Bureau did not accept for filing SpaceX's request for operations in the 42.0-42.5 GHz band because there is no domestic allocation for satellite services. *See* 47 CFR § 2.106; *see also infra* note 8 (explaining why SpaceX's request for authorization at 51.4-52.4 GHz, although accepted for filing, is also not under consideration here).

<sup>6</sup> SpaceX Application, Legal Narrative at 9.

<sup>7</sup> SpaceX Application, Waiver Requests. Specifically, SpaceX requests waivers of Sections 2.106, 25.202(a)(1), 25.143(b)(2)(ii), 25.156(d)(4), 25.156(d)(5), 25.157(e), 25.164(b), 25.208(r), and 25.114(c)(8) of the Commission's Rules, and waiver of various limitations of the Schedule S form.

<sup>8</sup> *Policy Branch Information, Space Stations Accepted for Filing*, Public Notice, Report No. SAT-01262 (IB Sat. Div. Aug. 25, 2017). SpaceX's entry in this public notice inadvertently included the 51.4-52.4 GHz frequency band. As noted in the Aug. 25, 2017 Public Notice, although a satellite application has been found acceptable for filing by the Satellite Policy Branch of the International Bureau, the Commission reserves the right to return any noticed application if, upon further examination, it is determined that the application is not in conformance with the Commission's rules or policies. There is no international or domestic allocation for satellite service in the 51.4-52.4 GHz frequency band. Accordingly, the acceptance for filing of SpaceX's request to operate in the 51.4-52.4 GHz frequency band was in error. We therefore dismiss SpaceX's request to operate in this band, and limit our review to SpaceX's request to operate in the 50.4-51.4 GHz frequency band. We note, however that Boeing filed a petition for rulemaking to, among other things, establish an allocation for satellite services in the 51.4-52.4 GHz band, which was placed on public notice and is pending. Consumer and Governmental Affairs Bureau Reference Information Center Petition for Rulemaking Filed, RM No. 11773, Public Notice, Report No. 3051, Daily Digest (Sept. 16, 2016). Depending on Commission action on the Boeing request or any future Commission action concerning FSS operation in this band, SpaceX may at a later time refile its request for FSS operation in the 51.4-52.4 GHz frequency bands.

<sup>9</sup> Hughes Network Systems, LLC Comments (filed Sept. 25, 2017) (Hughes). SES S.A. and O3b Limited Comments (Sept. 25, 2017) (SES and O3b). ViaSat, Inc. Comments (Sept. 25, 2017) (ViaSat); ViaSat Reply (Oct. 23, 2017). Comments of WorldVu Satellites Limited (Sept. 25, 2017) (OneWeb).

<sup>10</sup> SpaceX Consolidated V-Band Response (filed Oct. 10, 2017) (SpaceX Consolidated Response).

<sup>11</sup> ViaSat Reply (Oct. 23, 2017); SES and O3b Reply (Oct. 23, 2017).

<sup>12</sup> *Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Report and Order and Further Notice of Proposed Rulemaking, 32 FCC Rcd 7809 (2017) (*NGSO FSS R&O*).

<sup>13</sup> Most of these rule changes went into effect on January 17, 2018. *See* 82 Fed. Reg. 59972 (Dec. 18, 2017). The amendments to Sections 25.114, 25.115, 25.146, and 25.164, however, contained new and modified information collection requirements that required approval by the Office of Management and Budget (OMB) under the

November 2017, the Commission adopted the *Spectrum Frontiers Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order*,<sup>14</sup> which, among other things, made or affirmed determinations that the 40-42 GHz and 48.2-50.2 GHz bands will be reserved for FSS use,<sup>15</sup> while limiting satellite operations to communications with individually licensed earth stations in the 37.5-40.0 GHz and 47.2-48.2 GHz frequency bands.<sup>16</sup> The Commission also affirmed the existing Power Flux Density (PFD) limit applicable to satellite operations in the 37.5-40.0 GHz band.<sup>17</sup> To the extent that SpaceX requests waiver of rules already addressed in the *Spectrum Frontiers* proceeding, we consider those requests taking into account the decisions made in that proceeding. Where rules are modified as a result of future actions in the *Spectrum Frontiers* proceeding, or in other proceedings such as the rulemaking addressing NGSO FSS operations,<sup>18</sup> SpaceX's FSS operations will be subject to those modified rules. We discuss these matters with greater specificity below.

### III. DISCUSSION

5. After review of the record, we conclude that grant of the SpaceX application will serve the public interest, subject to the requirements and conditions specified herein. Below, we address the various outstanding issues raised by commenters on SpaceX's application.<sup>19</sup> We also address SpaceX's waiver requests. Where appropriate, we defer matters of general applicability to ongoing or potential future rulemakings.

6. *Request for FSS Operations in the 40-42 GHz Band.* In the *Spectrum Frontiers* proceeding, the Commission decided to reserve the 40-42 GHz band for FSS use.<sup>20</sup> Furthermore, SpaceX's proposed use of the 40-42 GHz band is consistent with the Commission's rules and the Table of Frequency allocations.<sup>21</sup> We therefore grant SpaceX's request for operations in this band as conditioned below.

(Continued from previous page) \_\_\_\_\_

Paperwork Reduction Act, and these amendments therefore did not become effective until May 31, 2018. *See Updates Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 83 FR 22391-01 (May 15, 2018) (announcing OMB approval of information collection requirements and setting effective date for rule amendments containing those requirements).

<sup>14</sup> *Use of Spectrum Bands Above 24 GHz for Mobile Radio Services et. al.*, Second Report and Order, Second Further Notice of Proposed Rulemaking, Order on Reconsideration, and Memorandum Opinion and Order, 32 FCC Rcd 10988 (2017). When citing to the *Second Report and Order* portion of the document, we will refer to the *Second R&O*, when citing to the *Second Further Notice of Proposed Rulemaking* portion of the document, we will refer to the *Second FNPRM*, and when citing to the *Memorandum Opinion and Order* portion of the document, we will refer to the *MO&O*.

<sup>15</sup> *Spectrum Frontiers MO&O*, 32 FCC Rcd at 11050-51, paras. 189, 192.

<sup>16</sup> *Id.* at 11005, 11061, paras. 55, 220.

<sup>17</sup> *Id.* at 11058-60, paras 214-216.

<sup>18</sup> *NGSO FSS Report and Order*. *See also Update to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, Notice of Proposed Rulemaking, 31 FCC Rcd 13651 (2016) (*NGSO FSS NPRM*).

<sup>19</sup> SES and O3b requested that the Commission include - in any SpaceX authorization--- standard operating conditions and specifically, several of the same grant conditions included on O3b's initial market access. *See* SES and O3b Comments at 6-7. To the extent that the SpaceX application raises the same concerns as other authorized NGSO FSS systems, we impose substantially identical conditions on SpaceX as we did in those orders, including O3b's recent grant, which also included V-band frequencies. In addition, since O3b's initial market access grant, the Commission has adopted significant revisions to its rules and policies governing NGSO FSS systems. The conditions herein are consistent with these rule changes.

<sup>20</sup> *Spectrum Frontiers MO&O*, 32 FCC Rcd at 11051, para. 192.

<sup>21</sup> U.S. Table of Frequency Allocations, 47 CFR § 2.106.

7. *Request for FSS Operations in the 47.2-50.2 GHz Band.* The 47.2-48.2 GHz portion of the band is currently allocated in the U.S. Table of Allocations for FSS, fixed service, and mobile service, limited to non-Federal stations, and the 48.2-50.2 GHz portion is allocated for these same services for both Federal and non-Federal stations.<sup>22</sup> In the *Spectrum Frontiers Second R&O*, the Commission decided to limit operations to individually-licensed earth stations in the 47.2-48.2 GHz portion of the band, which will also be authorized for terrestrial Upper Microwave Flexible Use Service (UMFUS) operations, and it declined to provide any mechanism for satellite end user equipment in that band.<sup>23</sup> In addition, earth station operations in the FSS in the 47.2-48.2 GHz band must not cause interference to stations in the fixed and mobile services, except where the individually licensed earth stations are authorized under Section 25.136 of the Commission's rules.<sup>24</sup> In the *Spectrum Frontiers Second Report and Order*, the Commission indicated that the 48.2-50.2 GHz portion of the band will be reserved for FSS use, including for deployment of satellite user terminals.<sup>25</sup> We grant SpaceX's request for operations in the 47.2-50.2 GHz band, subject to the rules adopted in the *Spectrum Frontiers* proceeding.

8. *Limits on Emissions into the 50.2-50.4 GHz Band.* In authorizing SpaceX's operations in the 47.2-50.2 GHz band, we have also taken into consideration concerns raised by some Federal agencies. The National Telecommunications and Information Administration (NTIA), on behalf of the National Aeronautics and Space Administration, the Department of Commerce, and the National Science Foundation, has expressed concerns about any proposed authorized out-of-band emission limits in the 50.2-50.4 GHz band that is designated for the Earth exploration-satellite service (EESS) (passive) use.<sup>26</sup> The NTIA indicated that these Federal agencies strongly opposed the future grant of NGSO FSS earth station licenses in the 49.7-50.2 GHz or 50.4-50.9 GHz bands operating in accordance with the emission limits in footnote US156 to Section 2.106 of the Commission's rules,<sup>27</sup> stating that out-of-band emissions from such earth stations would result in harmful interference to the operations of U.S. government assets

---

<sup>22</sup> Historically, the 47.2-50.2 GHz band has been subject to a band plan for sharing between wireless services and FSS. In 1998, as part of the V-band plan, the Commission designated the lower segment of the band, 47.2-48.2 GHz for wireless services use, and the upper 48.2-50.2 GHz segment for FSS use. *Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands, et. al.*, First Report and Order, 13 FCC Rcd 24649, 24651, para. 2 (1998) (*V-band First R&O*). In 2003, the Commission noted that it was preserving the 47.2-48.2 GHz FSS uplink allocation for gateway operations, pairing with downlink operations in the 37.5-40.0 GHz band. *V-band Second R&O*, 18 FCC Rcd at 25457, para. 67. The upper portion of the band, 48.2-50.2 GHz (Earth-to-space) band is identified in international footnote 5.516B for use by high-density applications in the FSS in ITU Region 2. International Table of Frequency Allocations, 47 CFR § 2.106, footnote 5.516B. Earth station operations in the 47.2-50.2 GHz band, including limitations on such operations, will be addressed as part of the earth station licensing process.

<sup>23</sup> *Spectrum Frontiers Second R&O*, 32 FCC Rcd at 11006, para. 55. The Commission also noted that it was making 2 gigahertz of spectrum available for satellite end user devices in the adjacent 48.2-50.2 GHz band, where it refrained from adopting service rules for terrestrial mobile service providers. *Id.* at 11005-6, paras. 54-56.

<sup>24</sup> Section 25.136 specifies processes for earth station applicants in the 47.2-48.2 GHz band and includes procedures to enable sharing with UMFUS. 47 CFR § 25.136(d).

<sup>25</sup> *Spectrum Frontiers MO&O*, 32 FCC Rcd at 11050, para. 189.

<sup>26</sup> NTIA raised this concern during the coordination of certain requests to operate in portions of the V-band. See "Memorandum of Understanding between the Federal Communications Commission and the National Telecommunications and Information Administration," January 31, 2003 (MOU), available at [http://apps.fcc.gov/edocs\\_public/attachmatch/DOC-230835A2.pdf](http://apps.fcc.gov/edocs_public/attachmatch/DOC-230835A2.pdf).

<sup>27</sup> 47 CFR § 2.106, footnote US156. The same limits are also included in Section 25.202(j) of the Commission's rules, 47 CFR § 25.202(j).

in the adjacent 50.2-50.4 GHz band.<sup>28</sup> The NTIA requested that more stringent out-of-band limits be placed on such earth station operations to ensure that the Federal government's EESS operations at 50.2-50.4 GHz—particularly those aspects that are critical to its prediction of meteorological phenomena—are not compromised. As in the *O3b Order* and the *Audacity Order*<sup>29</sup>, the Commission acknowledges the significant concerns expressed by the NTIA and notes that this unwanted emissions issue could be considered in a future Commission action. Therefore, although we require SpaceX to comply with the out of band emission limits currently in footnote US156 to Section 2.106 of the Commission's rules for its operations in the 49.7-50.2 GHz and 50.4-50.9 GHz bands,<sup>30</sup> we also explicitly condition SpaceX's authorization upon compliance with any future limits applicable to unwanted emissions in this band that may be adopted, either because of modifications approved by the 2019 World Radiocommunication Conference (WRC-19), or as a result of any future Commission rulemaking, independent of any ITU deliberation.<sup>31</sup>

9. *Sharing with GSO FSS Systems.* The Commission does not currently have service rules relevant to sharing between NGSO and GSO FSS systems in the frequency bands that SpaceX requested in its application. There are currently no FCC-licensed GSO FSS systems operating in the bands SpaceX has requested, although one GSO satellite application was recently granted.<sup>32</sup> ViaSat requested that grant be conditioned on compliance with No. 22.2 of the ITU Radio Regulations and the results of international coordination until the Commission adopts specific limits to protect GSO systems from interference by NGSO systems in the V-band.<sup>33</sup> SES and O3b requested that the Commission defer action on NGSO V-band applications until adequate sharing mechanisms are in place to avoid interference to GSO systems.<sup>34</sup> Hughes requested that the Commission condition any grant of the SpaceX application upon compliance with any applicable EPFD or technical limits that may be adopted by the Commission or ITU in the future, and that the Commission consider applying interim or default EPFD limits comparable to those in Article 22 of the ITU Radio Regulations.<sup>35</sup>

---

<sup>28</sup> Specifically, the NTIA asserts that out-of-band emissions would degrade data collection capability and would impact both domestic and international weather forecasting such as hurricane trajectories and the probability of tornado development.

<sup>29</sup> O3b Limited, Request for Modification of U.S. Market Access for O3b Limited's Non-Geostationary Satellite Orbit System in the Fixed-Satellite Service and in the Mobile-Satellite Service, *Order and Declaratory Ruling*, FCC 18-70, para. 30 (rel. June 6, 2018) (*O3b Order*). Audacity Corporation, Application for Authority to Launch and Operate a Non-Geostationary Medium Earth Orbit Satellite System in the Fixed- and Inter-Satellite Services, *Order and Authorization*, FCC 18-72, para. 20 (rel. June 6, 2018) (*Audacity Order*).

<sup>30</sup> 47 CFR § 2.106, footnote US156.

<sup>31</sup> A possible revision to the limits applicable to unwanted emissions in the 50.2-50.4 GHz band was included in ITU Resolution 750 (REV. WRC-15) and is being considered under WRC-19 Agenda Item 1.6.

<sup>32</sup> Hughes Network Systems, LLC was authorized to launch and operate a GSO satellite that includes operations in the 40-42 GHz (space-to-Earth) and 47.2-50.2 GHz (Earth-to-space) bands. Hughes Network Systems, IBFS File Nos. SAT-LOA-20170621-00092 and SAT-AMD-20170908-00128 (granted in part and deferred in part Mar. 20, 2018). The Commission deferred consideration of Hughes' request for operations in the 50.4-51.4 GHz band. *Id.*

<sup>33</sup> ViaSat Comments at 5-7; ViaSat Reply at 1-3. ITU Radio Regulation No. 22.2 states that NGSO systems shall not cause unacceptable interference to, and shall not claim protection from, GSO FSS and broadcasting-satellite service (BSS) networks operating in accordance with the Radio Regulations. ITU R.R. No. 22.2.

<sup>34</sup> SES and O3b Comments at 3-5.

<sup>35</sup> Hughes Comments at 2. In connection with this request, Hughes generally proposes that the Commission initiate a rulemaking to adopt NGSO/GSO sharing criteria and band-specific service rules for the 37.5-42.0 GHz, 47.2-50.2 GHz, and 50.4-51.4 GHz frequency bands. *Id.* at 1. It further requests that the Commission conduct an independent assessment of the appropriate single-entry and aggregate EPFD limits for these frequency bands. *Id.* at 2. For the reasons set forth in paragraph 10 *infra*, we have concluded that initiation of such a rulemaking and independent assessment is unwarranted and unnecessary, particularly in light of the adoption in the *NGSO FSS Report and Order*

10. In the *NGSO FSS Report and Order*, the Commission adopted a new rule in Section 25.289 requiring that, unless otherwise provided in the rules, an NGSO system licensee must not cause unacceptable interference to, or claim protection from, a GSO FSS or Broadcasting-Satellite Service (BSS) network.<sup>36</sup> Accordingly, a condition requiring compliance with Section 25.289 is included in this grant. Article 22 of the ITU Radio Regulations contains provisions to ensure compatibility of NGSO FSS operations with GSO networks.<sup>37</sup> However, we recognize that within the 37.5 GHz to 51.4 GHz range there are currently no ITU EPFD limits or specific coordination mechanisms for NGSO FSS systems. SpaceX's authorization will be subject to modification to bring it into conformance with any rules or policies adopted by the Commission in the future. Therefore, if relevant EPFD limits or other procedures are adopted by the Commission, or to the extent applicable, by the ITU in the future, SpaceX's operations must comply with those limits or procedures. We believe that these conditions adequately address the concerns raised by the commenters about spectrum sharing among GSO and NGSO systems. Additionally, given the initiation of studies at the ITU of technical and operational issues and regulatory provisions related to sharing between NGSO and GSO systems,<sup>38</sup> we decline the request by Hughes to develop our own interim or default EPFD limits for the SpaceX system. Because of the global nature of most NGSO systems, we find it is more appropriate for these limits to be developed internationally.

11. *Orbital Debris Mitigation.* An applicant for a space station authorization must submit a description of the design and operational strategies that it will use to mitigate orbital debris, including a statement detailing post-mission disposal plans for space stations at the end of their operating life.<sup>39</sup> SpaceX provided an orbital debris mitigation analysis as part of its application.<sup>40</sup> Thereafter, the Satellite Division (Division) sent a letter to SpaceX requesting additional information regarding its orbital debris mitigation plan.<sup>41</sup> On April 20, 2017, SpaceX provided answers to the Division's questions.<sup>42</sup>

12. The concerns raised by commenters regarding SpaceX's orbital debris mitigation plan for its V-band system are similar to those raised and addressed in connection with SpaceX's Ka/Ku-band constellation, but raise a few additional issues regarding operation of SpaceX's VLEO constellation. Specifically, OneWeb asserts that SpaceX's application does not quantify the intra-constellation conjunction distances, in nominal and potential failure modes, for either the LEO or VLEO constellations, or discuss how accurately SpaceX will be able to maintain its satellites' orbits, especially in the high-drag VLEO environment. Additionally, OneWeb states that the Commission should require SpaceX to address the aggregate casualty risk of surviving silicon carbide components,<sup>43</sup> and its system's proximity to the orbit of the International Space Station (ISS).<sup>44</sup>

13. In its reply, SpaceX asserts that many of OneWeb's comments overlook, or fail to

(Continued from previous page) \_\_\_\_\_  
of Section 25.289 of the Commission's rules (which post-dated the filing of the Hughes Comments) and the conditions we are placing on the grant of the authorization at issue here.

<sup>36</sup> 47 CFR § 25.289.

<sup>37</sup> See generally ITU R.R. Article 22, Section II.

<sup>38</sup> ITU-R Resolution 159 (WRC-15).

<sup>39</sup> *Mitigation of Orbital Debris*, Second Report and Order, 19 FCC Rcd 11567, 11619 (2004); 47 CFR §25.114(d)(14).

<sup>40</sup> See SpaceX Application, Technical Attachment, Section A.11, at 49-67.

<sup>41</sup> See Letter from Jose P. Albuquerque, Chief, Satellite Division, to William M. Wiltshire, Counsel to SpaceX (dated June 22, 2017) (*June 22 Letter*).

<sup>42</sup> See Letter from William M. Wiltshire, Counsel to SpaceX, to Jose P. Albuquerque, Chief, Satellite Division (dated July 24, 2017).

<sup>43</sup> OneWeb Comments at 8.

<sup>44</sup> *Id.* at 7.

acknowledge, technical information that SpaceX has already submitted to address these matters in great detail. For example, SpaceX provided detailed information on the orbital tolerances that its system will maintain and asserts that OneWeb's comments suggest that the Commission apply standards to SpaceX that the Commission has never previously considered or applied to any other licensed satellite system.<sup>45</sup>

14. SpaceX also argues that OneWeb's comments greatly overstate the potential risk of conjunctions within the SpaceX constellation, and that OneWeb ignores information already provided regarding operational features of the SpaceX system that reduce conjunction risk.<sup>46</sup> SpaceX further argues that OneWeb patently misconstrues NASA information to suggest potential for risk to the ISS.<sup>47</sup>

15. SpaceX also notes that it continues to refine its operational strategies to enhance safety, citing an ongoing simulation with the Joint Space Operations Center (JSpOC), in which a fleet of 100 simulated satellites are receiving warnings of conjunction events from JSpOC's actual catalog, and performing simulated maneuvers in response. SpaceX indicates that it has designed a rigorous maneuver response procedure to react to any JSpOC conjunction warning messages, including future enhancements afforded by the Space Fence,<sup>48</sup> to tightly control overall constellation risk.<sup>49</sup> Furthermore, SpaceX states that its satellites "are designed with propulsion systems capable of performing frequent maneuvers to avoid any satellite or trackable orbital debris."<sup>50</sup>

16. As previously stated in the *SpaceX NGSO Order*, while we appreciate the level of detail and analysis that SpaceX has provided for its orbital debris mitigation and end-of-life disposal plans, we conclude that the unprecedented number of satellites proposed by SpaceX and the other NGSO FSS systems in this processing round will necessitate a further assessment of the appropriate reliability standards of these spacecraft, as well as the reliability of these systems' methods for deorbiting the spacecraft.<sup>51</sup> Accordingly, we condition grant of the application on SpaceX presenting and the Commission granting a modification of this space station grant to include a final orbital debris mitigation

---

<sup>45</sup> SpaceX Reply Comments at 10-11.

<sup>46</sup> *Id.* at 14. SpaceX states that "in the rare case where location data indicates an elevated level of conjunction risk, the VLEO satellites will retain full maneuvering capability to avoid any LEO satellites for the duration of their very short de-orbit period." *Id.*

<sup>47</sup> *Id.*, asserting that OneWeb ignores the fact that for nearly a decade, the ISS has operated at a higher altitude that is more than 50 km above that proposed for use by SpaceX, and that OneWeb based its concerns on a graph of ISS operational altitudes over time that actually depicts an anomalous period in 2006 when the ISS operated at an unusually low altitude in order to facilitate delivery of very heavy construction payloads.

<sup>48</sup> The Space Fence is a sophisticated system that will dramatically improve the way the U.S. Air Force (through its operation of JSpOC) identifies and tracks objects in space, using Gallium Nitride (GaN) powered S-band ground-based radars to provide the Air Force with detection, tracking and accurate measurement of space objects, primarily in low-earth orbit.

<sup>49</sup> SpaceX Reply Comments at 11.

<sup>50</sup> *Id.* SpaceX indicates that it will largely be using recommendations set forth in both NASA Technical Standard 8719.14A and Air Force Instruction 91-217, and, where necessary, choosing a more restrictive value than either reference due to the scope of the project. It further indicates that it will internally review orbit debris mitigation as part of the preliminary design review and critical design review for the spacecraft, and incorporate these objectives, as appropriate, into its operational plans.

<sup>51</sup> NASA's comments to SpaceX's Ku/Ka-Band system apply equally to SpaceX's V-band system. *See* NASA Comments (filed June 26, 2017) (noting that (1) the reliability of the design and fabrication of the spacecraft and the reliability that the spacecraft can accomplish the post-mission disposal are of particular interest from the perspective of keeping the orbital environment safe, and that currently, no consensus exists on what the two reliability numbers should be, and (2) a design and fabrication reliability on the order of 0.999 or better per spacecraft may be prudent to mitigate the risk of malfunction in a 4,000+ spacecraft constellation).

plan.<sup>52</sup> We note that the Commission recently opened a proceeding that proposes to update the current orbital debris rules. SpaceX's updated orbital debris mitigation plan must comply with any new rules adopted by the Commission in this proceeding.<sup>53</sup> Additionally, SpaceX will be subject to the same orbital debris mitigation conditions as other authorized NGSO systems, including a requirement that it coordinate its physical operations with space stations of NGSO systems operating at similar orbital altitudes.<sup>54</sup> To the extent that SpaceX and other NGSO operators fail to come to an agreement regarding physical coordination, the Commission may intervene as appropriate.

17. *Waiver Standard.* SpaceX seeks waivers of several of the Commission's rules.<sup>55</sup> Generally, the Commission may waive any rule for good cause shown.<sup>56</sup> Waiver is appropriate where the particular facts make strict compliance inconsistent with the public interest.<sup>57</sup> In making this determination, we may take into account considerations of hardship, equity, or more effective implementation of overall policy on an individual basis.<sup>58</sup> Waiver is therefore appropriate if special circumstances warrant a deviation from the general rule, such deviation will serve the public interest, and the waiver does not undermine the validity of the general rule.<sup>59</sup> We address the specific requests for waivers below.

18. *Request for FSS Operations in the 37.5-40.0 GHz Band and Associated Waivers.* This band is currently allocated to the fixed and mobile services on a primary basis. While this band is also allocated to the FSS (space-to-Earth), Part 25 of the Commission's rules limits all FSS operations to communications with individually licensed earth stations.<sup>60</sup> Part 25 further states that earth stations in this band must not be ubiquitously deployed and must not be used to serve individual consumers.<sup>61</sup> In addition, earth station operations in the FSS shall not claim interference protection from stations in the fixed and mobile services, except where the individually licensed earth stations are authorized under Section 25.136 of the Commission's rules.<sup>62</sup> Part 25 also includes PFD limits applicable to operations in the 37.5-40.0 GHz frequency band. Section 25.208(r) includes limits for both operations under assumed free space conditions and operations during periods when the FSS system raises power to compensate for

---

<sup>52</sup> The modification should include, among other things, a discussion of any steps that SpaceX has taken to coordinate physical operations with authorized and proposed NGSO systems at similar orbital altitudes (both for the main mission and disposal phases); a discussion of the level of data-sharing that would be required with other operators, including analysis of likely requirements for ephemeris refresh rates and time frames for coordination of planned maneuvers (both for the main mission and disposal phases); and whether SpaceX has considered alternative orbital altitudes for its operations and whether those altitudes would materially affect SpaceX's ability to provide service.

<sup>53</sup> *Mitigation of Orbital Debris in the New Space Age*, Notice of Proposed Rulemaking, FCC 18-159 (rel. Nov. 19, 2018).

<sup>54</sup> See, e.g., *Telesat Ka-band Order*, 32 FCC Rcd at 9675.

<sup>55</sup> SpaceX requests waivers of Sections 2.106, 25.202(a)(1), 25.143(b)(2)(ii), 25.156(d)(4), 25.156(d)(5), 25.157(e), 25.164(b), 25.208(r), and 25.114(c)(8) of the Commission's rules, and, to the extent necessary, various limitations in the Commission's Schedule S. SpaceX Waiver Requests.

<sup>56</sup> 47 CFR § 1.3.

<sup>57</sup> *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1164, 1166 (D.C. Cir. 1990).

<sup>58</sup> *WAIT Radio v. FCC*, 418 F.2d 1153, 1159 (D.C. Cir. 1969), cert. denied, 409 U.S. 1027 (1972); *Northeast Cellular*, 897 F.2d at 1166.

<sup>59</sup> *NetworkIP, LLC v. FCC*, 548 F.3d 116, 125-28 (D.C. Cir. 2008); *Northeast Cellular*, 897 F.2d at 1166; *WAIT Radio*, 418 F.2d at 1158.

<sup>60</sup> 47 CFR § 25.202(a)(1)(ii).

<sup>61</sup> *Id.*

<sup>62</sup> 47 CFR § 25.136.

rain-fade conditions at the earth station. In the *Spectrum Frontiers Second Report and Order*, the Commission found that the record did not establish conditions under which FSS could operate at a higher PFD consistent with terrestrial use of the band.<sup>63</sup> However, that Order did not delete a note to Section 25.208(r), which states that the conditions under which satellites may exceed the PFD limits for free space conditions to compensate for the effects of rain fading have not yet been defined and provides that the conditions and extent to which the free space limits can be exceeded will be the subject of a further rulemaking by the Commission.<sup>64</sup>

19. SpaceX seeks to use the 37.5-40.0 GHz spectrum for downlink communications to both user terminals and gateways, *i.e.*, ubiquitously deployed earth stations in a band shared with terrestrial operations, and thus requests a waiver of Part 25 and Section 2.106 to permit such operation.<sup>65</sup> Additionally, SpaceX requests waiver of the Commission's downlink PFD limits in Sections 25.208(r) and 25.114(c)(8) of the Commission's rules, stating that the Commission's PFD limits in the 37.5-40.0 GHz band are 12 dB lower than the corresponding PFD limits imposed under the ITU's rules, and 12 dB more stringent than the Commission's own limits in the adjacent 40.0-42.0 GHz band.<sup>66</sup> SpaceX provides an analysis to demonstrate that its proposed operations in this band would have a *de minimis* effect on terrestrial mobile and fixed wireless operations, *e.g.*, its user terminals will only communicate with satellites at angles of at least 35 degrees, meaning that transmissions from satellites to user terminals would be far off-axis from terrestrial links, which tend to be pointed approximately tangent to the surface of the Earth.<sup>67</sup> It further states that its receiving earth stations will not seek any interference protection from terrestrial system transmissions, and so their operation will not constrain the further development of those services in this band.<sup>68</sup> Thus, SpaceX indicates that will comply with the ITU PFD limits for the 37.5-40.0 GHz band, but will exceed the more restrictive limits imposed by the Commission at elevation angles above 35 degrees.

20. In the recently adopted *Spectrum Frontiers MO&O*, the Commission declined to permit satellite operations in the 37.5-40.0 GHz band at higher PFD levels than the existing limits applicable to clear sky conditions.<sup>69</sup> The Commission also declined to allow satellite user equipment in the 37.5-40 GHz band on a ubiquitous basis because of a concern that allowing satellite user equipment in the band could result in a negative consumer experience for satellite broadband consumers.<sup>70</sup> In the *Spectrum Frontiers MO&O*, we fully considered the same arguments presented by SpaceX's Application in support of these waiver requests,<sup>71</sup> and therefore consistent with our determinations in the *Spectrum Frontiers MO&O* and the rationale underlying those determinations, we deny SpaceX's requests for waiver of Sections 2.106, 25.202(a)(1)(ii), and 25.208(r).

21. In connection with its request for a waiver of Section 25.208(r), SpaceX also asks for a waiver of Section 25.114(c)(8), which specifies that applicants must provide the calculated maximum

---

<sup>63</sup> *Spectrum Frontiers Second Report and Order*, paras. 214-216.

<sup>64</sup> 47 CFR § 25.208(r), NOTE TO PARAGRAPH (r). There appears to be a typographical error in the note to paragraph (r). The note refers to paragraph (q)(1), but it should refer to paragraph (r)(1) for the PFD limits applicable to NGSO systems under assumed free space conditions.

<sup>65</sup> SpaceX requested a waiver of Section 25.202(a)(1) note 6, but apparently meant note 1, which specifically refers to the type of operations requested. In any case, as the substance of the rule was moved to Section 25.202(a)(1)(ii), we will treat SpaceX as having requested a waiver of that section.

<sup>66</sup> SpaceX Waiver Requests at 16.

<sup>67</sup> *Id.* at 16-17.

<sup>68</sup> *Id.* at 3.

<sup>69</sup> *Spectrum Frontiers MO&O*, 32 FCC Rcd at 11058-60, paras. 214-216.

<sup>70</sup> *Id.* at 11061, paras. 219-220.

<sup>71</sup> *Id.*

PFD levels within each coverage area needed for compliance with Section 25.208, for the angles of arrival specified in the applicable paragraphs of Section 25.208.<sup>72</sup> Consistent with our denial of SpaceX's waiver request of Section 25.208(r), SpaceX's request for a waiver of the Section 25.114(c)(8) related informational requirement is similarly denied.

22. *Request for FSS Operations in the 50.4-51.4 GHz Band and Associated Waivers.* SpaceX seeks authorization for uplinks in the 50.4-51.4 GHz band.<sup>73</sup> This band is allocated in the U.S. Table of Frequency Allocations to the FSS, but at the time SpaceX filed its application the 50.4-51.4 GHz band was not listed among the available frequencies for FSS in Section 25.202(a)(1) of the rules. SpaceX requested a waiver of the Section 25.202(a)(1) list of available frequencies for FSS.<sup>74</sup> The Commission recently decided to remove the list of frequencies in Section 25.202(a)(1) as unnecessary,<sup>75</sup> thereby eliminating this barrier against applying for FSS use of the frequencies in the 50.4-51.4 GHz band. Accordingly, SpaceX's request for a waiver of Section 25.202(a)(1) is dismissed as moot.

23. In the *V-band First Report and Order*, the Commission designated the 50.4-51.4 GHz segment for use by fixed and mobile service.<sup>76</sup> The Commission recently proposed authorizing fixed and mobile use under the UMFUS rules in the 50.4-51.4 GHz band in the *Spectrum Frontiers Order and Further Notice*,<sup>77</sup> but has not yet acted on this issue.<sup>78</sup> Rather than act on access to this band prematurely, we defer action until sharing between terrestrial and satellite operations in the band, as well as other uses of the band, are addressed in the context of the *Spectrum Frontiers Proceeding*. After such sharing and other uses are addressed, we will act on the request for operation in 50.4-51.4 GHz without the need for any further filing from SpaceX.

24. *Sharing with NGSO Systems and Waiver of Band-Splitting Procedure.* Until recently, Section 25.157(e) of the Commission's rules provided that "available spectrum" be "divided equally" among the applications granted as the result of a processing round.<sup>79</sup> This rule presumed that NGSO operators could not use the same frequencies without causing harmful interference to each other, and therefore must be assigned discrete segments of the requested band. SpaceX requests a waiver of Section 25.157(e), stating that its system can share spectrum with other NGSO FSS systems.<sup>80</sup> In the *NGSO FSS Report and Order* we adopted rule changes that apply a spectrum sharing mechanism to all authorized NGSO FSS systems that include a condition of grant requiring compliance with Section 25.261.<sup>81</sup> As in other NGSO FSS authorizations, we include such a condition requiring SpaceX to comply with the spectrum sharing requirements specified in Section 25.261 with respect to any other NGSO system licensed or granted U.S. market access pursuant to the processing round in which SpaceX participated for all operations within the United States.<sup>82</sup> Accordingly, SpaceX's request for waiver of Section 25.157(e) is no longer needed and is dismissed as moot.

---

<sup>72</sup> SpaceX Waiver Requests at 16-18. 47 CFR § 25.114(c)(8)

<sup>73</sup> *Id.* at 7-8.

<sup>74</sup> *Id.* at 7-8. 47 CFR § 2.106.

<sup>75</sup> *NGSO FSS R&O*, 32 FCC Rcd at 7817-18, para. 27.

<sup>76</sup> *V-Band First Report and Order*, 13 FCC Rcd at 24651 (jointly referring to fixed and mobile services as "wireless service").

<sup>77</sup> *Spectrum Frontiers Order and Further Notice*, 31 FCC Rcd at 8158.

<sup>78</sup> *Spectrum Frontiers Second Report and Order*, n.35.

<sup>79</sup> 47 CFR § 25.157(e).

<sup>80</sup> SpaceX Waiver Requests at 12-14.

<sup>81</sup> *NGSO FSS R&O*, 32 FCC Rcd at 7825-26, paras. 48-50.

<sup>82</sup> 47 CFR § 25.261. *See also O3b Order* and *Audacy Order*.

25. *Waiver of Milestone Requirement.* SpaceX requests partial waiver of Section 25.164(b) of the Commission's rules, which requires NGSO system licensees to launch the space stations, place them into the assigned orbits, and operate them in accordance with the station authorization within six years of grant of the license.<sup>83</sup> SpaceX asks that we apply the six-year milestone only to its initial deployment of 1,600 satellites.<sup>84</sup> SpaceX states that completing its full constellation of over 11,943 satellites over a six-year period would require an unprecedented launch cadence, which would be impractical, and that deployment of its full constellation is not necessary to allow it to commence delivery of broadband service. SpaceX argues that a limited waiver of Section 25.164(b) would not undermine the purpose of the milestone requirements, as it would not result in, facilitate, or encourage spectrum warehousing. Several commenters argue that a waiver of this requirement would give SpaceX an unfair advantage as it would not require SpaceX to deploy its full constellation within the six-year period without further obligation to deploy the rest of its system.<sup>85</sup>

26. We agree with commenters that SpaceX has not provided sufficient grounds for a waiver of the Commission's final implementation milestone requirement. We note that this issue was addressed in the NGSO FSS rulemaking,<sup>86</sup> and this grant is subject to those rules. Under these new rules, SpaceX's deployment of 1,600 satellites would not meet the new 6-year milestone requirement that now requires 50 percent of the total number of satellites in the constellation to be launched and operated no later than 6 years after grant of the authorization. Given that, we deny SpaceX's waiver request. SpaceX can resubmit this request in the future, when it will have more information about the progress of the construction and launching of its satellites and will therefore be in a better position to assess the need and justification for a waiver.

27. *Geographic Coverage Requirements.* SpaceX requests a partial waiver of the default geographic coverage requirements for all NGSO systems where band-specific rules do not apply.<sup>87</sup> That provision includes both an international and a domestic requirement. First, the system must have at least one satellite that would be visible above the horizon at an elevation angle of at least 5 degrees for at least 18 hours each day, for any location between 70° North Latitude and 55° South Latitude. Second, the system must have at least one satellite that would be visible above the horizon at an elevation angle of at least 5 degrees at all times throughout the fifty states, Puerto Rico, and the U.S. Virgin Islands.<sup>88</sup> SpaceX states that once fully deployed, the SpaceX system will satisfy these requirements, as it will provide full time coverage to virtually the entire planet.<sup>89</sup> We find that waiver of the default geographic coverage is unnecessary, since the Commission's geographic service rules apply to the "proposed system," which in the case of SpaceX is the full system of satellites that was proposed and authorized. Given that SpaceX's proposed system as a whole will meet the geographic coverage requirements, a waiver of the requirements is not needed for interim stages and we therefore dismiss SpaceX's waiver request.

---

<sup>83</sup> 47 CFR § 25.164(b).

<sup>84</sup> Application, Waiver Requests at 15-16. SpaceX indicates that its initial deployment of 1,600 satellites within the six-year period is comparable to the full deployment of many other providers and would allow it to commence service to the public. *Id.* See also SpaceX Consolidated V-Band Reply at 3-4.

<sup>85</sup> OneWeb Comments at 2-3 (stating that failure to rigorously enforce the Commission's milestone regime increases the risk of spectrum and "space real estate" warehousing, and that Space should be required to comply with milestone requirement that is implemented as a result of the ongoing NGSO rulemaking proceeding); Hughes Comments at 2 (Hughes objects to SpaceX's open-ended request for waiver of the Commission's milestone obligations without a commitment to launch its full constellation on a timely basis and states that it is not in the public interest and should be denied).

<sup>86</sup> *NGSO FSS Order*, 32 FCC Rcd at 7830-31, para. 67.

<sup>87</sup> 47 CFR §§ 25.217 and 25.143(b)(2)(ii).

<sup>88</sup> SpaceX Waiver Requests at 9.

<sup>89</sup> *Id.* at 9-10.

28. *Section 25.156(d)(4) Waiver.* SpaceX requests a waiver of Section 25.156(d)(4) of the Commission's rules.<sup>90</sup> Section 25.156(d)(4) provides that the Commission will consider applications for authority to operate feeder links separately from applications to provide service.<sup>91</sup> However, SpaceX's V-band constellation is an FSS system and by definition does not have feeder links,<sup>92</sup> making waiver of Section 25.156(d)(4) unnecessary and we therefore dismiss SpaceX's request as moot.

29. *Section 25.156(d)(5) Waiver.* SpaceX requests a waiver of Section 25.156(d)(5) of the Commission's rules.<sup>93</sup> Section 25.156(d)(5) stated that in frequency bands where the Commission has not adopted band specific service rules it will not consider applications for NGSO-like operation after it has granted an application for GSO-like operation, and vice-versa, unless and until the Commission establishes NGSO/GSO sharing criteria for that frequency band.<sup>94</sup> The Commission recently eliminated Section 25.156(d)(5) in the *NGSO FSS R&O*<sup>95</sup> and this rule change is now in effect. Consequently, SpaceX's request for a waiver of this requirement is moot.

30. *Schedule S Waiver.* As required by the Commission's rules, SpaceX submitted a completed Schedule S for its application, which contains certain technical information in a prescribed form. SpaceX has found that it cannot accurately describe its system in certain respects due to limitations in Schedule S itself. SpaceX cites three limitations in Schedule S that affected how the Schedule S was completed: (1) the inability to enter "not applicable" for Section 25.114(c)(4)(v); (2) the inability of Schedule S to process all of the orbital parameter data for the SpaceX System;<sup>96</sup> (3) the inability of the Schedule S to accommodate the information and data necessary to reflect SpaceX's system architecture for spare satellites.<sup>97</sup> To the extent necessary, SpaceX requests that the Commission waive these aspects of Schedule S in light of these limitations. In view of the fact that SpaceX has implemented a workaround for each of these limitations to allow entry of the required information, we find that a waiver of the requirement to complete certain aspects or fields of Schedule S is warranted.

#### IV. ORDERING CLAUSES

31. Accordingly, IT IS ORDERED, that the Application filed by Space Exploration Holdings, LLC (SpaceX) and accepted for filing, IS GRANTED IN PART, DEFERRED IN PART, and DISMISSED IN PART, as set forth in this Memorandum Opinion, Order and Authorization, pursuant to Section 309(a) of the Communications Act of 1934, as amended, 47 U.S.C. § 309(a).

32. IT IS FURTHER ORDERED that this authorization is subject to the following requirements and conditions:

- a. SpaceX must timely provide the Commission with the information required for Advance Publication, Coordination, and Notification of the frequency assignment(s) for this constellation, including due diligence information, pursuant to Articles 9 and 11 of the ITU

---

<sup>90</sup> *Id.* at 10-11.

<sup>91</sup> 47 CFR § 25.156(d)(4).

<sup>92</sup> 47 CFR § 25.103 (defining a feeder link as a "radio link from a fixed earth station at a given location to a space station, or vice versa, conveying information for a space radiocommunication service other than the Fixed-Satellite Service").

<sup>93</sup> SpaceX Waiver Requests at 11-12.

<sup>94</sup> 47 CFR § 25.156(d)(5).

<sup>95</sup> *NGSO FSS R&O*, 32 FCC Rcd at 7821-22, para. 39.

<sup>96</sup> SpaceX provided a sample of that data in the electronic version of Schedule S and states that it will deliver to the Commission a database with the complete information required on Schedule S, including orbital parameters, for inclusion in the record of this application. *See* SpaceX Application, Waiver Requests at 18-19. SpaceX subsequently delivered a database which contains the required information.

<sup>97</sup> *Id.* at 19.

Radio Regulations. This authorization may be modified, without prior notice, consistent with the coordination of the frequency assignment(s) with other Administrations. *See* 47 CFR § 25.111(b). SpaceX is responsible for all cost-recovery fees associated with the ITU filings. 47 CFR § 25.111(d).

- b. Operations in the 37.5-40.0 GHz band are unprotected with respect to the non-federal fixed and mobile services, except as authorized pursuant to 47 CFR § 25.136.
- c. Operations in the 37.5-40.0 GHz band are authorized up to the power flux-density limits in 47 CFR § 25.208(r)(1). Prior to starting operation in this band, SpaceX must present the showing described in Section 25.114(c)(8) to confirm compliance with these power flux-density limits.
- d. Operations in the 37.5-38.0 GHz and 40.0-40.5 GHz bands must be successfully coordinated with Federal Space Research Service (SRS) facilities, pursuant to Recommendation ITU-R SA.1396, "Protection Criteria for the Space Research Service in the 37-38 GHz and 40.0-40.5 GHz Bands."
- e. Operations in the 40-42 GHz band are authorized up to the power-flux density limits in 47 CFR § 25.208(s) and (t).
- f. In accordance with footnote US211 to 47 CFR § 2.106, SpaceX is urged to take all practicable steps to protect radio astronomy observations in the adjacent bands from harmful interference from its operations in the 40.5-42 GHz band.
- g. Operations in the 47.2-48.2 GHz band must provide interference protection to the fixed and mobile services, except as authorized pursuant to 47 CFR § 25.136.
- h. Any future grant of earth station licenses for operations with the SpaceX system will be subject to the following condition, unless the condition is satisfied prior to such license grant: in the 48.94-49.04 GHz band, operations must be coordinated with radio astronomy stations operating on a co-primary basis in this band. Operations in the 47.2-50.2 GHz band will be subject to the rules adopted in the *Spectrum Frontiers Proceeding*, GN Docket 14-177.
- i. In accordance with footnote US342 to 47 CFR § 2.106, SpaceX is urged to take all practicable steps to protect radio astronomy observations from harmful interference from its operations in the 48.94-49.04 GHz band.
- j. Earth station emissions into the 50.2-50.4 GHz band must comport with the limits contained in ITU-R Resolution 750 (REV. WRC-15) and/or footnote US156 to Section 2.106 of the Commission's rules, 47 CFR § 2.106, footnote US156, including any future revisions of footnote US156 to Section 2.106. Such revisions may be introduced either because of modifications that may be approved by WRC-19 to Resolution 750, or as a result of a Commission rulemaking proceeding, independent of any ITU deliberation.
- k. Operations must comply with the spectrum sharing procedures among NGSO FSS space stations specified in 47 CFR § 25.261 with respect to any NGSO system licensed or granted U.S. market access pursuant to the processing round initiated in Public Notice, DA 16-1244. Spectrum sharing between SpaceX's operations and operations of NGSO systems granted U.S. market access, where such operations do not include communications to or from U.S. territory, are governed only by the ITU Radio Regulations and are not subject to Section 25.261.
- l. Operations shall not cause interference to, and shall not claim protection from, GSO networks operating in the FSS and BSS in accordance with Section 25.289 of the Commission's rules, 47 CFR § 25.289. In the event that relevant EPFD limits or procedures related to sharing between GSO and NGSO networks are adopted by the Commission or the ITU, operations must be in conformance with such limits and procedures.

- m. SpaceX must comply with the sharing of ephemeris data procedures described in new Section 25.146 of the Commission's rules, 47 CFR § 25.146(e).<sup>98</sup>
- n. SpaceX 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.
- o. Upon finalization of its space station design and prior to initiation of service, SpaceX must seek and obtain the Commission's approval of a modification containing an updated description of the orbital debris mitigation plans for its system, as discussed in paragraph 16 above.

33. IT IS FURTHER ORDERED that this authorization is subject to modification to bring it into conformance with any rules or policies adopted by the Commission in the future. Accordingly, in making any investments relating to operations in the bands authorized in this order, SpaceX assumes the risk that such operations may be subject to additional conditions or requirements as a result of any future Commission actions.

34. IT IS FURTHER ORDERED that this grant is subject to the following requirements:
- a. SpaceX must post a surety bond in satisfaction of 47 CFR §§ 25.165(a)(1) & (b) no later than **December 19, 2018**, and thereafter maintain on file a surety bond requiring payment in the event of a default in an amount, at minimum, determined according to the formula set forth in 47 CFR § 25.165(a)(1); and
  - b. SpaceX must launch 50 percent of the maximum number of proposed space stations, place them in the assigned orbits, and operate them in accordance with this grant no later than **November 19, 2024**, and must launch the remaining space stations necessary to complete its authorized service constellation, place them in their assigned orbits, and operate them in accordance with the authorization no later than **November 19, 2027**. 47 CFR § 25.164(b).

Failure to post and maintain a surety bond will render this grant null and void automatically, without further Commission action. Failure to meet the milestone requirements of 47 CFR § 25.164(b) may result in SpaceX's authorization being reduced to the number of satellites in use at the milestone date. Failure to comply with the milestone requirements of 47 CFR § 25.164(b) will also result in forfeiture of SpaceX's surety bond. By **December 4, 2024**, SpaceX must either demonstrate compliance with this milestone requirement or notify the Commission in writing that the requirement was not met. 47 CFR § 25.164(f).

35. IT IS FURTHER ORDERED that SpaceX's request for operations in the 42.0-42.5 GHz and 51.4-52.4 GHz bands ARE DISMISSED for the reasons set forth herein. IT IS FURTHER ORDERED that the request for waiver of 47 CFR § 25.202(a)(1), concerning the availability of the 50.4-51.4 GHz band for FSS, IS DISMISSED as MOOT for the reasons set forth herein.

36. IT IS FURTHER ORDERED that, based on the condition above requiring spectrum sharing consistent with 47 CFR § 25.261, the request for a waiver of 47 CFR § 25.157(e) IS DISMISSED as MOOT for the reasons set forth herein.

37. IT IS FURTHER ORDERED that the request for waiver of 47 CFR § 25.156(d)(4), concerning processing of applications for authority to operate feeder links separately from applications to provide service, IS DISMISSED as MOOT for the reasons set forth herein.

38. IT IS FURTHER ORDERED that the request for waiver of 47 CFR § 25.156(d)(5), concerning processing of NGSO applications, IS DISMISSED as MOOT for the reasons set forth herein.

---

<sup>98</sup> In the *NGSO FSS Order*, we extended the requirement for NGSO FSS operators to share ephemeris data to all frequency bands in which NGSO FSS systems operate. See *NGSO FSS Order*, 32 FCC Rcd at 7828, para. 58 n.131.

39. IT IS FURTHER ORDERED that SpaceX's request for authorization to operate using the 50.4-51.4 GHz band for service and gateway uplinks IS DEFERRED pending Commission action in the *Spectrum Frontier's Proceeding*, GN Docket 14-177.

40. IT IS FURTHER ORDERED that the request for suspension of the 47 CFR § 25.164(b) satellite construction milestones for final deployment IS DENIED.

41. IT IS FURTHER ORDERED that the request for waiver of 47 CFR § 25.202(a)(1)(ii) IS DENIED.

42. IT IS FURTHER ORDERED that SpaceX's request for waivers of Sections 2.106, 25.114(c)(8) and 25.208(r) of the Commission's rules, 47 CFR §§ 2.016, 25.114(c)(8), and 25.208(r), concerning the U.S. Table of Allocation and power flux density limits in the 37.5-40.0 GHz band IS DENIED.

43. IT IS FURTHER ORDERED that the request for waiver of Geographic Service Requirements as to international and domestic coverage IS DISMISSED.

44. IT IS FURTHER ORDERED that the request for waivers relating to the use of the Schedule S form IS GRANTED.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch  
Secretary

**STATEMENT OF  
CHAIRMAN AJIT PAI**

Re: *Space Exploration Holdings, LLC Application for Approval for Orbital Deployment and Operating Authority for the SpaceX V-band NGSO Satellite System, IBFS File No. SAT-LOA-20170301-00027; In the Matter of Kepler Corporation Petition for Declaratory Ruling to Grant Access to the U.S. Market for Kepler's NGSO FSS System, IBFS File No. SAT-PDR-20161115-00114; In the Matter of Telesat Canada Petition for Declaratory Ruling to Grant Access to the U.S. Market for Telesat's V-band NGSO Constellation, IBFS File No. SAT-PDR-20170301-00023; In the Matter of LeoSat MA, Inc., Petition for Declaratory Ruling Concerning U.S. Market Access for the LeoSat Ka-band Low-Earth Orbit Satellite System, IBFS File No. SAT-PDR-20161115-00112.*

Today, we're considering applications involving four proposed constellations of non-geostationary orbit satellites. Two of them involve repeat players; two involve startups. One proposed constellation would be authorized by the United States; three would be authorized by foreign governments and receive U.S. market access. But what they all have in common is the promise of variety in the burgeoning field of non-geostationary satellite services and innovative solutions to bridging the digital divide.

From providing high-speed broadband services in remote areas to offering global connectivity to the Internet of Things through "routers in space" for data backhaul, I'm excited to see what services these proposed constellations have to offer. Our approach to these applications reflects this Commission's fundamental approach: encourage the private sector to invest and innovate and allow market forces to deliver value to American consumers.

I'd also like to take a moment to recognize the staff of the International Bureau, not just for their efforts in bringing up to the Commission the items we're considering at this meeting, but for their ongoing efforts over these past two years. Since last June, the Commission has approved 13 market access requests and satellite applications to nine companies for NGSO systems, including the four that we add to the list today. This productivity is primarily due to your hard work and expertise. Thanks to your efforts, I'm optimistic that the American people will benefit from new satellite-based services.

In particular, I'd like to express my gratitude to Jose Albuquerque, Christopher Bair, Jennifer Balatan, Curtrisha Banks, Stephen Duall, Jennifer Gilson, Joseph Hill, Karl Kensinger, Sylvia Lam, Julia Malette, Kathryn Medley, Sankar Persaud, Cindy Spiers, Tom Sullivan, Troy Tanner, and Jay Whaley from the International Bureau. I'd also thank those from other Bureaus and Offices who have played a critical role in advancing these items: Michael Ha, Nick Oros, and Jamison Prime from the Office of Engineering and Technology; Stephen Buenzow, John Schauble, and Becky Schwartz from the Wireless Telecommunications Bureau; and Deborah Broderon, David Horowitz, and Bill Richardson from the Office of General Counsel.

**STATEMENT OF  
COMMISSIONER MICHAEL O'RIELLY**

Re: *Space Exploration Holdings, LLC Application for Approval for Orbital Deployment and Operating Authority for the SpaceX V-band NGSO Satellite System, IBFS File No. SAT-LOA-20170301-00027; In the Matter of Kepler Corporation Petition for Declaratory Ruling to Grant Access to the U.S. Market for Kepler's NGSO FSS System, IBFS File No. SAT-PDR-20161115-00114; In the Matter of Telesat Canada Petition for Declaratory Ruling to Grant Access to the U.S. Market for Telesat's V-band NGSO Constellation, IBFS File No. SAT-PDR-20170301-00023; In the Matter of LeoSat MA, Inc., Petition for Declaratory Ruling Concerning U.S. Market Access for the LeoSat Ka-band Low-Earth Orbit Satellite System, IBFS File No. SAT-PDR-20161115-00112.*

These are exciting times in the development and deployment of new global satellite constellations that will serve consumers. Not since the early 1990s have satellite systems received such attention and captured the imagination of what new technologies, including high-speed broadband offerings, may bring. This also comes with some apprehension as few can predict which satellite systems, if any, will succeed or make money, and existing satellite offerings are indeed being subject to greater scrutiny. But, this new race to satellite orbit provides a first-class seat to the dreams of visionaries, and I look forward to seeing what NGSO systems develop and what services are eventually offered. Quite frankly, our job at the Commission is to approve the qualified applications and then let the market work its will.

In these four items, the Commission approves four additional systems, which will add at least another 7,859 satellites into orbit, if everything goes according to the submitted plans; and this comes on top of the nine applications and petitions the Commission has approved over the last 17 months. Between SpaceX's current application and the one previously consented to by the Commission, SpaceX alone is envisioning a future constellation of an unprecedented 11,943 satellites. As I said earlier today, new technologies – especially ones that revolutionize an industry model – oftentimes require the Commission to modernize and streamline our rules to provide a limited, but sound, framework to deal with accompanying policy issues. That is what today is all about.

I support granting the SpaceX application and the Kepler, LeoSat, and Telesat petitions for market access. While there are still issues to be explored, including communications with ESIMs and orbital debris, and policy calls that we may not have gotten quite right, such as how we handle in-line interference, the Commission continues to take the necessary steps to allow investment and future deployment of these ambitious projects.

I approve.

**STATEMENT OF  
COMMISSIONER BRENDAN CARR**

Re: *Space Exploration Holdings, LLC Application for Approval for Orbital Deployment and Operating Authority for the SpaceX V-band NGSO Satellite System, IBFS File No. SAT-LOA-20170301-00027; In the Matter of Kepler Corporation Petition for Declaratory Ruling to Grant Access to the U.S. Market for Kepler's NGSO FSS System, IBFS File No. SAT-PDR-20161115-00114; In the Matter of Telesat Canada Petition for Declaratory Ruling to Grant Access to the U.S. Market for Telesat's V-band NGSO Constellation, IBFS File No. SAT-PDR-20170301-00023; In the Matter of LeoSat MA, Inc., Petition for Declaratory Ruling Concerning U.S. Market Access for the LeoSat Ka-band Low-Earth Orbit Satellite System, IBFS File No. SAT-PDR-20161115-00112.*

Never before have there been so many companies using such diverse technologies to connect Americans—and that is phenomenal news. We used to focus on improved speeds over copper, and then fiber, and then over the air using LTE. Today, the buzz includes fixed wireless and gigabit connections powered by high-band spectrum and 5G. With these four decisions, we authorize another tool in the broadband toolbox: large constellations of satellites in low-earth orbit.

These satellites are smaller and less expensive to launch than the traditional geostationary satellites that have been going up since the 1960s. They promise lower latency connections because they typically orbit only a few hundred miles above Earth, as opposed to many thousands. Many corners of our country that don't have broadband today, or don't have many broadband choices, could soon see new, high-speed services thanks to these low-earth orbit satellites. At least two of the applicants we consider today plan to offer services that could enable IoT devices—powering smart cities and smart ag. And those use cases complement the many connections satellites make today on ships, airplanes, and other vehicles.

The broader point is that, at this moment, innovation in tech and telecom has the extraordinary potential to benefit everyday Americans. As we move towards 5G, satellite, fiber, cable, fixed wireless, and a range of other offerings are all going to compete for your broadband dollars. And we can help move competition in that direction through smart policies.

That's what we're doing today. We're not picking winners and losers in the competition to provide more broadband to more Americans. We don't have the foresight to centrally plan the particular mode of connectivity everyone will use. Recognizing this is a good thing. After all, if your family is getting fast, affordable broadband, you probably don't care whether that connection is through a low-earth satellite or high-band spectrum. So that's the approach we take here. We let these four companies move forward and allow the market to decide their success.

For my part, I am excited to see what services these four companies will offer. And I'm glad we're clearing the way for more choices and more connections for Americans, regardless of where they live. Once again, I want to thank the International Bureau for its work on these items. They have my support.

**STATEMENT OF  
COMMISSIONER JESSICA ROSENWORCEL**

Re: *Space Exploration Holdings, LLC Application for Approval for Orbital Deployment and Operating Authority for the SpaceX V-band NGSO Satellite System, IBFS File No. SAT-LOA-20170301-00027; In the Matter of Kepler Corporation Petition for Declaratory Ruling to Grant Access to the U.S. Market for Kepler's NGSO FSS System, IBFS File No. SAT-PDR-20161115-00114; In the Matter of Telesat Canada Petition for Declaratory Ruling to Grant Access to the U.S. Market for Telesat's V-band NGSO Constellation, IBFS File No. SAT-PDR-20170301-00023; In the Matter of LeoSat MA, Inc., Petition for Declaratory Ruling Concerning U.S. Market Access for the LeoSat Ka-band Low-Earth Orbit Satellite System, IBFS File No. SAT-PDR-20161115-00112.*

The United Nations is well known for its Human Development Index. It's a lot like a national report card. It's a composite of indicators involving life expectancy, education, and per capita income. As indices go, this one gets all the glory at the General Assembly. But there's another United Nations index that deserves some time in the spotlight—and that's the Index of Objects Launched into Outer Space. Moreover, it's one that directly informs our satellite work at the Federal Communications Commission.

According to this index, there are currently 4,857 satellites orbiting the globe. If you start counting from the fall of 1957, when Russia's Sputnik became earth's first artificial star, a total of 8,126 objects have been launched into space.

Now consider this. Today this agency is approving more than 7,500 new satellites for orbit. That's on top of more than 4,500 new satellites already authorized this year. Then consider that we have another 1,200 proposed satellites still in our pipeline for review.

Do the math. It adds up to a next-generation space race. New commercial models, players, and technologies are coming together and rapidly multiplying the range of satellite services. With these services come all kinds of opportunities. They include new capacities to connect more people in more places, use scarce resources more efficiently, support expanded access to education and health care, and grow economies beyond the limits of today's terrestrial networks. In other words, they could help with improving the very sorts of things that are measured by the United Nations in its Human Development Index. This is exciting.

Of course, increasing the number of satellites in orbit like this brings new challenges. That's because left unchecked, the growing amount of debris in orbit could make some regions of space unusable for decades to come. This should concern us all—because junking up our far altitudes will constrain our ability to innovate, connect, and make progress with satellite systems.