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

In the Matter of	)	
SPACE EXPLORATION HOLDINGS, LLC	)	Call Sign: S3069
Amendment to Pending Application for the SpaceX Gen2 NGSO Satellite System	)	File No. SAT-AMD-2021_____

AMENDMENT

William M. Wiltshire
Paul Caritj

HARRIS, WILTSHIRE & GRANNIS LLP
1919 M Street, N.W.
Suite 800
Washington, DC 20036
202-730-1300 tel
202-730-1301 fax

Counsel to SpaceX

David Goldman
Director of Satellite Policy

SPACE EXPLORATION TECHNOLOGIES CORP.
1155 F Street, N.W.
Suite 475
Washington, DC 20004
202-649-2700 tel
202-649-2701 fax

August 18, 2021

SUMMARY

SpaceX applied last year for authority to deploy and operate its next-generation Gen2 System, an NGSO satellite system using Ku-band, Ka-band, and E-band frequencies. This Gen2 System was designed to complement the first-generation constellation SpaceX is currently deploying, which has begun to deliver truly high-speed, low-latency broadband across the United States—including to the most remote corners and Polar Regions of the country that too often get left behind. While the original constellation provides unprecedented capacity for a satellite system, the demand for more broadband continues to grow unabated and the need for user connectivity has never been more important.

Given this accelerating demand, SpaceX could not sit idle in the year since filing its application. Instead, SpaceX has invested substantial resources to research and develop more efficient and effective ways to optimize its system to deliver service to more customers more quickly. Most significantly, SpaceX has found ways to leverage the advanced capabilities of its new launch vehicle, Starship, that has increased capability to deliver more mass to orbit quickly and efficiently and, combined with reuse capability of the upper stage, launch more often. With this increased potential, Starship allows SpaceX to better position satellites to meet changing consumer demand. Further, Starship allows SpaceX to iterate from its original satellite design and deploy next-generation satellites with more capacity and throughput, providing even further improvements for consumers to its already high-throughput, low-latency service.

At the same time, SpaceX may supplement its launch capacity by using its reliable Falcon 9 rocket to launch the next-generation satellites. Accordingly, in this application SpaceX proposes two alternative system configurations—similar to the approach allowed for network filings with the International Telecommunication Union—for alternative system and satellite designs. By

providing complete information on both configurations now, SpaceX will enable the Commission to evaluate both approaches even as development proceeds. Once the timeline becomes clear, SpaceX would notify the Commission which of the two configurations it wishes to deploy.

In Configuration 1—SpaceX's preferred scenario—the amendment proposed herein would revise the pending application in three main respects to fully leverage these new capabilities:

1. SpaceX will more evenly spread capacity by latitude by targeting multiple inclinations, ensuring better, more consistent global coverage even as it continues to operate at lower, more sustainable altitudes than most other NGSO systems.
2. SpaceX will nearly double the number of satellites deployed in a sun-synchronous orbit optimized for key throughput demand times and service to Polar Regions, resulting in additional capacity for those chronically underserved areas such as Alaska.
3. The revised orbital planes will enable "single plane" launch campaigns, not requiring long dwell times in a low parking orbit waiting for orbital precession to spread satellites into other planes. These satellites can launch, be checked out at low altitude, and can all quickly go to their on-station positions.

Configuration 2 utilizes a smaller number of satellites per plane than Configuration 1, yet also spreads capacity more evenly by latitude for more consistent coverage across the globe.

Neither configuration requests any additional spectrum or results in a significant increase in the potential for interference to any other spectrum user, including other NGSO licensees and current applicants. Although SpaceX proposes to rearrange the orbital parameters of its Gen2 System, it will slightly reduce the number of satellites in the constellation. Moreover, SpaceX will continue to leverage the inherent advantages of operating at lower altitudes than most NGSO constellations. Not only will atmospheric drag at these altitudes ensure that any debris quickly

disintegrates in the atmosphere and pose no further danger to space operations or life on the ground, but operation at these altitudes is also consistent with a key recommendation from the astronomical community to minimize any effect on astronomical observations.

SpaceX will not rest in its efforts to take of advantage of its unique iterative approach to extend true broadband connectivity to those on the wrong side of the digital divide—especially those in remote areas. Its ongoing efforts to innovate and optimize have yielded two alternative proposals for a revised design of the Gen2 System that will each better meet consumers' demand for high-capacity, low-latency broadband service. Critically, these changes do not require additional spectrum resources, will not increase interference to other spectrum users, and will continue to ensure safety of the orbital environment, and thus do not affect the status of the pending application with respect to any applicable processing round cut-off date. Accordingly, the Commission should grant the application as amended.

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

In the Matter of	)	
SPACE EXPLORATION HOLDINGS, LLC	)	Call Sign: S3069
Amendment to Pending Application for the SpaceX Gen2 NGSO Satellite System	)	File No. SAT-AMD-2021_____

AMENDMENT

Space Exploration Holdings, LLC ("SpaceX") submits this amendment to its pending application for its next-generation non-geostationary orbit ("NGSO") satellite system (the "Gen2 System").[1] The changes proposed herein are the product of SpaceX's ongoing iterative approach to develop both a powerful new launch vehicle called Starship and new state-of-the-art satellites. In addition, this amendment proposes two alternative configurations for the revised constellation. Configuration 1 fully leverages the upgraded satellite capabilities and the availability of Starship, bringing significantly increased capability to deliver satellites to orbit. Configuration 2 provides an alternative that also leverages the capabilities of the reliable Falcon 9 rocket. The application provides complete information on the changes proposed under both configurations for the Commission's consideration.

SpaceX can achieve these benefits under either configuration without requesting any additional spectrum or resulting in a significant increase in the potential for interference to any

[1] *See* Application for Approval of Orbital Deployment and Operating Authority for the SpaceX Gen2 NGSO Satellite System, IBFS File No. SAT-LOA-20200526-00055 (filed May 26, 2020) ("Original Application").

other NGSO licensee or applicant in the 2020 NGSO Processing Round,[2] making it a minor amendment that does not affect the status of the pending Gen2 System application with respect to the applicable processing round cut-off date.[3] Under either configuration, the revised Gen2 System will further optimize service to customers and better meet demand for low-latency, high-bandwidth broadband services, especially in underserved and unserved areas, all while using slightly fewer satellites. Accordingly, the Commission should grant the application as amended.

BACKGROUND

As part of the 2020 NGSO Processing Round initiated by the International Bureau, SpaceX filed an application requesting authority to deploy and operate its Gen2 System, an NGSO satellite system in the Fixed-Satellite Service ("FSS") using Ku-band, Ka-band, and E-band frequencies.[4] This Gen2 System was designed to complement the first-generation constellation SpaceX is currently deploying, which is already delivering truly high-speed, low-latency broadband across the United States—including to the most remote corners and Polar Regions of the country that too often get overlooked and left behind. While that constellation provides unprecedented capacity for a satellite system, the past year and a half have demonstrated the extraordinary need for even more connectivity. Accordingly, just as terrestrial wireless operators are deploying millions of new antennas as part of densified 5G networks to meet these needs in more urban environments, SpaceX proposed this new densified satellite constellation to substantially increase capacity and

---

2 *See* Public Notice, *Cut-Off Established for Additional NGSO FSS Applications or Petitions for Operations in the 10.7-12.7 GHz, 12.75-13.25 GHz, 13.8-14.5 GHz, 17.7-18.6 GHz, 18.8-20.2 GHz, and 27.5-30 GHz Bands*, 35 FCC Rcd. 2881 (IB 2020) (establishing 2020 NGSO Processing Round).

3 *See* 47 C.F.R. § 25.116(b) and (c).

4 Like SpaceX's currently authorized NGSO system, the Gen2 System will use optical inter-satellite links for communications directly between SpaceX satellites. As the Commission has previously found, "[b]ecause optical ISLs do not involve wire or radio frequency transmissions, the Commission does not have jurisdiction over the use of optical ISLs." *Teledesic LLC*, 14 FCC Rcd. 2261, ¶ 14 (Int'l Bur. 1999). Moreover, to the extent that the use of optical ISLs alleviates congestion in radio frequency bands, it is to be encouraged. *Id.*

drive up the number of consumers even in rural and remote areas that will have access to truly robust broadband, albeit with many fewer antennas than those deployed by terrestrial operators.

But SpaceX did not simply wait while its application has been pending. Instead, SpaceX made significant investments in its unique iterative approach to develop more efficient and effective ways to optimize service for consumers. For example, SpaceX has taken its experience with its first-generation deployment to advance the design of its Gen2 System and further develop its next-generation satellites to provide increased capacity, creating a new opportunity for a revised deployment that more precisely places bandwidth where it is needed most. It has monitored market trends to understand developments since it filed its Original Application, enabling a plan to better position satellites to meet consumer demand for broadband services. In addition, SpaceX can leverage its powerful Starship launch vehicle, the next-generation heavy lift rocket that will be able to deliver more satellites to orbit at one time and to place them in a way that will facilitate faster activation. SpaceX has combined this additional satellite and launch capability with a more robust understanding of demand, enabling a plan to better position satellites meet people's real needs for broadband on the ground. But because development of either satellites or the launch vehicle may accelerate faster than anticipated, SpaceX has developed plans leveraging different launch capabilities. In this application, it provides complete information on both configurations to the extent they differ from the original proposal.

DISCUSSION

SpaceX's current application proposed a Gen2 System configured as shown in Table 1.

Altitude (km)	Inclination (degrees)	Orbital Planes	Satellites per Plane	Total Satellites
328	30	1	7,178	7,178
334	40	1	7,178	7,178
345	53	1	7,178	7,178
360	96.9	50	40	2,000
373	75	1	1,998	1,998
499	53	1	4,000	4,000
604	148	12	12	144
614	115.7	18	18	324

Table 1. Original Gen2 System Orbital Parameters

Configuration 1 would amend the orbital parameters in SpaceX's pending application in three main respects. First, SpaceX would target multiple inclinations to more evenly spread capacity by latitude, ensuring better, more consistent global coverage. Second, it would nearly double the number of satellites deployed in a sun synchronous orbit optimized for service to polar regions, resulting in additional capacity for those chronically underserved areas like Alaska. Third, the revised orbital planes would enable single plane launch campaigns that capitalize on the ability of Starship to deliver satellites at a faster pace by not necessarily requiring a waiting period for orbital precession in a parking orbit. SpaceX could deploy satellites into their operational orbits within a matter of weeks after launch, rather than months. In this configuration, SpaceX would deploy 29,988 satellites as set forth in Table 2.

Altitude (km)	Inclination (degrees)	Orbital Planes	Satellites per Plane	Total Satellites
340	53	48	110	5,280
345	46	48	110	5,280
350	38	48	110	5,280
360	96.9	30	120	3,600
525	53	28	120	3,360
530	43	28	120	3,360
535	33	28	120	3,360
604	148	12	12	144
614	115.7	18	18	324

Table 2. Amended Gen2 System Orbital Parameters (Configuration 1)

As discussed above, either the satellites or the launch vehicle could be developed faster than anticipated. Accordingly, SpaceX has devised an alternative arrangement (Configuration 2) that can be deployed using Falcon rockets yet still provides significant improvements over the existing proposal. For example, Configuration 2 would (like Configuration 1) target multiple inclinations to more evenly spread capacity by latitude, ensuring better, more consistent global coverage. In this scenario, SpaceX would deploy Constellation 2 as set forth in Table 3.

Altitude (km)	Inclination (degrees)	Orbital Planes	Satellites per Plane	Total Satellites
328	30	5,816	1	5,816
334	40	5,816	1	5,816
346	53	5,816	1	5,816
360	96.9	40	50	2,000
510	14	72	23	1,656
515	22	72	23	1,656
520	30	72	23	1,656
525	53	72	23	1,656
530	45	72	24	1,728
535	38	72	24	1,728
604	148	12	12	144
614	115.7	18	18	324

Table 3. Amended Gen2 System Orbital Parameters (Configuration 2)

Despite their differences in orbital parameters, these two configurations share several important characteristics. In neither case does SpaceX propose any changes to the spectrum requested in its Original Application.[5] In addition, neither proposes any change in the power flux-density ("PFD") of its signals on the Earth's surface or the minimum elevation angles at which earth stations will communicate with Gen2 satellites. SpaceX will also continue to avoid the GSO arc and take other measures as appropriate to comply with the equivalent power flux-density ("EPFD") limits in frequency bands where they apply.[6] As a result, as demonstrated in Attachment A to this application, neither alternative proposed in this amendment will increase the potential for interference to other licensed and proposed systems operating in these bands as compared to the Original Application. Moreover, in the event that an in-line event cannot be avoided, the

[5] In addition, the proposed changes in orbital parameters do not implicate the provisions for a "major" amendment under Section 25.116 of the Commission's rules. *See* 47 C.F.R. § 25.116. As the Commission has held, "the reference to 'orbital locations' in section 25.116(b)(1) is only applicable to GSO space station applications." *Viasat, Inc.*, 35 FCC Rcd. 4324, ¶ 12 (2020).

[6] *See* 47 C.F.R. § 25.146(a)(2).

availability of additional alternative satellites will maximize SpaceX's flexibility to work with other operators to find viable sharing strategies while continuing to serve subscribers and making efficient use of shared spectrum resources.

Similarly, SpaceX will continue to deploy satellites with its proven advanced collision-avoidance and propulsion systems that can respond quickly and at high cadence, allowing SpaceX to coordinate in advance and conduct active maneuvers to avoid collisions with both debris and non-maneuverable spacecraft throughout the life of its satellites, even through the de-orbit phase until the spacecraft enters the atmosphere. SpaceX here again certifies that upon receipt of a space situational awareness conjunction warning, it will review and take all possible steps to assess the collision risk, and will mitigate the collision risk if necessary—as it has with the over 1,700 first-generation satellites it has already launched. SpaceX plans to continue its practice of sharing information regarding initial deployment, ephemeris, and planned maneuvers with the 18th Space Control Squadron (or a successor entity) and other entities that engage in space situational awareness or space traffic management functions. SpaceX has the same ability to further engage in physical coordination with other NGSO systems using either configuration proposed in this amendment.[7]

Given the nature of this minor amendment, SpaceX does not restate its initial application in its entirety. Accordingly, the updated technical information provided herein should be read in conjunction with the Technical Attachment submitted with the Original Application, as well as the Schedule S forms accompanying this amendment, which have been amended and restated to reflect the operation of the entire Gen2 System as revised for both configurations.

---

[7] *See* Original Application, Attachment A at 46-48 (discussing physical coordination with other licensed and potential NGSO systems).

Grant of this application as amended will promote the public interest by enabling SpaceX to further optimize its Gen2 System to achieve all the objectives set forth in the Original Application. As the past 18 months have shown, the need for more low-latency, high-capacity broadband has never been more urgent. As discussed in the Original Application, despite the unprecedented capacity of SpaceX's first-generation constellation, SpaceX has proposed its Gen2 System to provide the additional resources needed to help meet the needs of American consumers by, for example, helping to close the homework gap, facilitating telework and telehealth arrangements, improving precision agriculture applications, and supporting national security and first responder capabilities.[8] The changes proposed in this amendment, under either configuration, will enable SpaceX to more efficiently and effectively meet these goals by arranging its satellites in a way that will better target capacity where it is needed and paving the way for deploying those satellites more quickly to their operational altitudes. Moreover, SpaceX will accomplish these improvements without creating any offsetting interference or other concerns.

In addition, this amendment reflects improvements in the design of Gen2 satellites themselves. For example, the satellites will be somewhat larger and generate more power, enabling them to support expanded capabilities now and accommodate additional payloads in the future. The Gen2 satellites will have enhanced reliability by building upon the design and operational history of the current deployment. While SpaceX was able to work extensively with the astronomy community to mitigate the reflectivity on its first-generation satellites, it has now taken that experience to design less reflective satellites from the beginning. Consistent with the recommendations of studies on reducing the potential impact of low-Earth orbit satellites on

[8] *See* Original Application at 2-5.

astronomical observations,[9] all of the satellites relocated in this amendment will continue to operate at altitudes below 600 km, which minimizes the period of night during which satellites are illuminated by the sun. SpaceX continues to develop operational and other strategies to reduce satellite reflectivity and support other mitigation activities as part of its ongoing collaboration with the astronomy community and outside experts. SpaceX will continue to work with the astronomy community and other stakeholders to minimize the potential impact of the Gen2 System on all those who wish to view the night sky.

Although this application proposes alternative amendments to the pending application, this concept is familiar to those who submit satellite network filings to the International Telecommunication Union ("ITU") to initiate the international process for deploying NGSO constellations. Specifically, in recognition that constellation designs mature through development, the ITU allows mutually exclusive configurations at the filing stage.[10] Each of these mutually exclusive configurations is independently evaluated to determine whether it meets the requirements for a favorable finding. As the satellite system is deployed, however, only one configuration may be notified and brought into use. If a pending modification has been made but has not yet received favorable findings by the time the notification deadline arrives, a single backup mutually exclusive configuration can be specified and used in the event that the primary configuration is not found to be suitable.

---

[9] *See, e.g.,* Walker et al., *Impact of Satellite Constellations on Optical Astronomy and Recommendations Toward Mitigations* 3-6 (2020) (recommending that operators "[d]eploy satellites at orbital altitudes no higher than ~600 km" to reduce reflectivity impact); Luc H. Riesbeck et al., Aerospace Corp., *The Future of the Night Sky: Light Pollution from Satellites* 3-8 (2020) (concluding that "[s]atellites at lower altitudes are brighter but have less impact because they move into Earth's shadow earlier than satellites at higher altitudes").

[10] The coordination information submitted to the ITU for NGSO systems must indicate whether it describes (1) a single configuration where all frequency assignments to the satellite system will be in use, or (2) multiple configurations that are mutually exclusive where a sub-set of the frequency assignments to the satellite system will be in use on one of the sub-sets of orbital parameters to be determined at the notification and recording stage of the satellite system. ITU Radio Regs., Appendix 4, Annex 2, Table A, Item A.4.b.1.b.

Thus, while the request for Commission consideration of two alternative configurations is not common, it is consistent with the international approach to NGSO regulation.

CONCLUSION

For the foregoing reasons, and for the reasons set forth in the Original Application and the materials accompanying this amendment, SpaceX requests that the Commission find that granting operating authority for SpaceX's Gen2 System, as amended to conform to either Configuration 1 or Configuration 2, would serve the public interest. The Commission should therefore issue such grant expeditiously.

Respectfully submitted,

SPACE EXPLORATION HOLDINGS, LLC

By: */s/ David Goldman*
David Goldman
Director of Satellite Policy

William M. Wiltshire
Paul Caritj
HARRIS, WILTSHIRE & GRANNIS LLP
1919 M Street, N.W.
Suite 800
Washington, DC 20036
202-730-1300 tel
202-730-1301 fax

Counsel to SpaceX

SPACE EXPLORATION TECHNOLOGIES CORP.
1155 F Street, NW
Suite 475
Washington, DC 20004
202-649-2700 tel
202-649-2701 fax

August 18, 2021