SPACEX 2.4 GHz MOBILE-SATELLITE SYSTEM
NON-GEOSTATIONARY SATELLITE SYSTEM

ATTACHMENT A
TECHNICAL INFORMATION TO SUPPLEMENT SCHEDULE S

A.1 SCOPE AND PURPOSE

This attachment contains the information required for SpaceX's use of the 1610-1617.775 and 2483.5-2500 MHz bands (the "1.6/2.4 GHz bands") as well as the 2020-2025 MHz band with a non-geostationary orbit ("NGSO") satellite system in the Mobile-Satellite Service ("MSS") required under Part 25 of the Commission's rules that cannot be fully captured by the Schedule S software. The accompanying Schedule S reflects the system as it will operate once modified and fully deployed.

A.2 OVERALL DESCRIPTIONS

This information is generally available in Attachment A ("Technical Information to Supplement Schedule S") to the previous applications related to SpaceX's first-generation Fixed-Satellite Service constellation (the "Gen1 FSS system").[1] Under the modification proposed herein, SpaceX would add a 1.6/2.4 GHz MSS payload as well as a 2020-2025 MHz MSS payload to each satellite in that system.

Orbital Parameters

The SpaceX 1.6/2.4 GHz and 2020-2025 MHz Mobile-Satellite Service system ("1.6/2.4

[1] *See* Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System, IBFS File No. SAT-LOA-20161115-00118 (Nov. 15, 2016); Application for Approval for Orbital Deployment and Operating Authority for the SpaceX NGSO Satellite System Supplement, IBFS File No. SAT-LOA-20170726-00110 (July 26, 2017); Application for Modification of Authorization for the SpaceX NGSO Satellite System, IBFS File No. SAT-MOD-20181108-00083 (Nov. 8, 2018); Application for Modification of Authorization for the SpaceX NGSO Satellite System, IBFS File No. SAT-MOD-20200417-00037 (Apr. 17, 2020). These materials are collectively referred to herein as the "Previous Applications."

GHz MSS") is an NGSO satellite system that will consist of a payload flown on the 4,408 satellites in SpaceX's first-generation FSS system as set forth below.[2]

SpaceX 1.6/2.4 GHz MSS System					
Orbital Planes	72	72	36	6	4
Satellites per Plane	22	22	20	58	43
Altitude	550 km	540 km	570 km	560 km	560 km
Inclination	53°	53.2°	70°	97.6°	97.6°

Table A.2-1. 1.6/2.4 GHz Mobile-Satellite Service System Orbital Parameters

Operation of the 1.6/2.4 GHz MSS system as a payload on these already-licensed satellites will have no effect on their orbital characteristics, which will remain as described in the Previous Applications and the first-generation FSS Authorization.

Technology and Operations

The 1.6/2.4 GHz MSS system will utilize advanced phased array beam-forming and digital processing technologies onboard each satellite payload in order to make highly efficient use of spectrum resources and share spectrum flexibly with other space-based and terrestrial-licensed users. The 1.6/2.4 GHz mobile satellite services will be available for residential, commercial, institutional, and governmental users in the U.S.

In making this application, SpaceX seeks to leverage its existing space resources to provide even more ubiquitous connectivity options to Americans with a goal of "global affordable connectivity." This includes the proposed 1.6/2.4 GHz MSS system, which follows SpaceX's expansion into this mobile services arena with its acquisition of Swarm Technologies, Inc.

[2] *See Space Exploration Holdings, LLC*, 36 FCC Rcd. 7995 (2021) ("Gen1 FSS Authorization").

("Swarm"), a company authorized to deploy and operate 150 small NGSO MSS satellites designed to provide narrowband services in the very-high frequency ("VHF") 137-138 MHz and 148-150.5 MSS bands.[3] Swarm has already launched most of its authorized satellites and is offering services to customers in the agriculture, maritime, energy, environmental, and transportation sectors, among others in need of global satellite connectivity for IoT devices. The combination of the proposed 1.6/2.4 GHz MSS system and the Swarm IoT connectivity solutions will truly encompass all ranges of data rates and power levels for devices around the world.

Spectrum

The frequency plan and satellite downlink parameters are provided in the Schedule S. The 1.6/2.4 GHz MSS system satellites will transmit with right-hand circular polarization ("RHCP") and left-hand circular polarization ("LHCP"). As discussed below, SpaceX will operate its 1.6/2.4 GHz MSS system without causing harmful interference to any other service duly licensed in the 1.6/2.4 GHz bands.

A.3 PREDICTED SPACE STATION ANTENNA GAIN CONTOURS

All 1.6/2.4 GHz MSS downlink spot beams on each SpaceX satellite are independently steerable. The antenna gain contours for the transmit and receive beams for a representative 1.6/2.4 GHz MSS payload operating at 540 km, 550 km, 560 km, and 570 km are embedded in the associated Schedule S, as required by Section 25.114(c)(4)(vi)(B). Information on TT&C beam contours is available in Attachment A to the Previous Applications.

[3] *See Satellite Policy Branch Information; Actions Taken*, Public Notice, DA 21-1238 (rel. Oct. 1, 2021) (confirming authority for Swarm transfer of control to SpaceX).

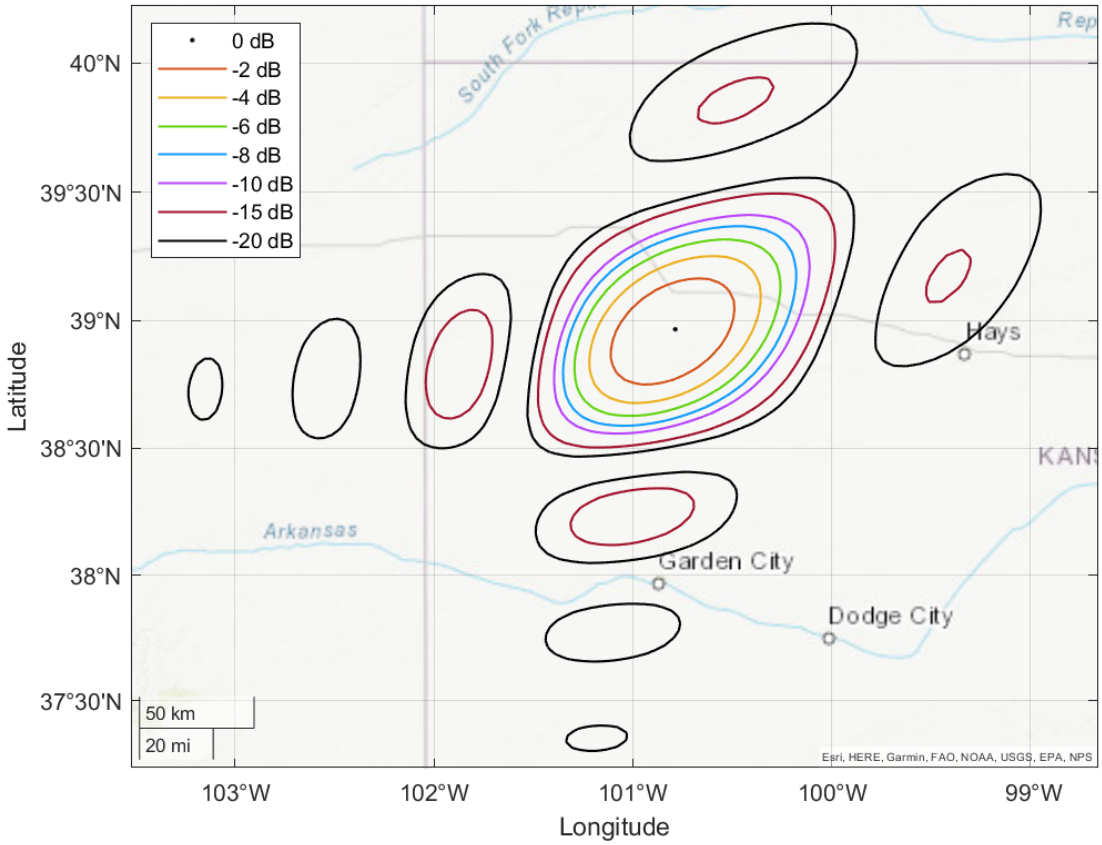

Figure A.3-1: Notional Beam Contours for a 35 Degree Off-Nadir Scan Angle Beam

A.4 TT&C CHARACTERISTICS

SpaceX will use the existing TT&C subsystem on its first-generation FSS system for communications with the spacecraft during pre-launch, transfer orbit, and on-station operations, as well as during spacecraft emergencies, consistent with the first-generation FSS Authorization. A complete description of the SpaceX TT&C subsystem is provided with the previous applications.

A.5 BACKHAUL OPERATIONS

The SpaceX 1.6/2.4 GHz MSS system backhaul will use the gateway links in the Ka-band spectrum already requested as part of its first-generation FSS system, generating high-gain steered beams to communicate with multiple satellites within the constellations from a single gateway site.

SpaceX is also deploying optical inter-satellite links to provide seamless network management and continuity of service while minimizing the spectrum footprint of the system overall and facilitating spectrum sharing with other space-based and terrestrial systems.

A.6 GEOGRAPHIC COVERAGE

As required in Sections 25.143(b)(2)(ii) and (iii) of the Commission's rules, at least one SpaceX 1.6/2.4 GHz MSS satellite will be visible above the horizon at an elevation angle of at least 5° for at least 18 hours each day within the geographic area as far north as 70° North latitude and as far south as 55° South latitude. In addition, at least one satellite will be visible above the horizon at an elevation angle of at least 5° at all times within the fifty states, Puerto Rico and the U.S. Virgin Islands.

A.7 CESSATION OF EMISSIONS

Each active satellite transmission chain can be individually turned on and off by ground telecommand, thereby causing cessation of emissions from the satellite, as required by Section 25.207 of the Commission's rules.

A.8 FREQUENCY TOLERANCE

The carrier frequency of each space station transmitter shall be maintained within 0.002 percent of the reference frequency, as required by Section 25.202(e) of the Commission's rules.

A.9 MEAN POWER OF EMISSIONS

In addition, the mean power of emissions shall comply with the limits required by Section 25.202(f) of the Commission's rules.

A.10 INTERFERENCE ANALYSES

The Commission has recognized that a proposed modification to an NGSO authorization

should be granted where it "does not present any significant interference problems and is otherwise consistent with Commission policies." As discussed in greater detail below, the advanced capabilities of SpaceX's proposed 1.6/2.4 GHz MSS system will enable effective and efficient spectrum sharing with other licensed users of the bands. Although SpaceX has filed a range of values in the Schedule S to demonstrate the technical capabilities of the system, it anticipates operating within limits set as discussed in the sections below.

MSS Downlink (2483.5-2500 MHz)

The SpaceX 1.6/2.4 GHz MSS system will comply with all relevant power-flux density ("PFD") limits in Section 25.208(v) for the 2496-2500 MHz band. Between 2483.5 and 2496 MHz, SpaceX requests the authority to operate up to an agreed upon PFD limit developed from good-faith coordination between co-frequency MSS operators, in line with the Commission's original intent to have multiple operators in the band.[4] SpaceX is confident that modern communication technologies, sophisticated phased-arrays, and advanced beam scheduling protocols inherent in its 1.6/2.4 GHz MSS system will prevent harmful interference into any modern, capable, and well-designed satellite or terrestrial system.

In addition, SpaceX requests authority to operate up to any future PFD limit should it be increased through a processing round, license application or modification of another MSS operator in the band, or for any other reason.

MSS Uplink (1610-1617.775 MHz)

The SpaceX 1.6/2.4 GHz MSS system will operate up to an agreed upon EIRP limit developed from good-faith coordination between co-frequency MSS operators based on good-faith

[4] *See Spectrum and Service Rules for Ancillary Terrestrial Components in the 1.6/2.4 GHz Big Leo Bands/Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bands*, Second Order on Reconsideration, Second Report and Order, and Notice of Proposed Rulemaking, 22 FCC Rcd 19733, ¶ 4 (2007)

coordination between co-frequency MSS operators and the Commission's original intent to have multiple operators in this band.

SpaceX is confident that modern communication technologies, sophisticated phased-arrays, and advanced beam scheduling protocols inherent in its 1.6/2.4 GHz MSS system will prevent harmful interference into any modern, capable, and well-designed satellite or terrestrial system.

In addition, SpaceX requests authority to operate up to any future EIRP limit should it be increased through a processing round, license application or modification of another MSS operator in this band, or for any other reason.

MSS Uplink (2020-2025 MHz)

As stated in the Legal Narrative, SpaceX seeks a waiver to operate an MSS uplink in the 2020-2025 MHz range consistent with the Kepler/Spire Petition. SpaceX will coordinate its operations with Spire and Kepler to ensure harmonized operations in this band and can cease operations should a report of harmful interference occur.

A.10 COORDINATION WITH U.S. GOVERNMENT NETWORKS

To the extent necessary, SpaceX will coordinate with the National Telecommunications and Information Administration ("NTIA") to protect any operations in a band from harmful interference and to ensure that they are compatible with Federal uses.

A.11 ITU FILINGS FOR SPACEX

SpaceX has not yet submitted system information for ITU publication. SpaceX will submit this information at the appropriate time to the Commission for filing through the U.S. and will unconditionally accept all consequent ITU cost-recovery responsibility for the filing.

A.12 ORBITAL DEBRIS MITIGATION

SpaceX hereby incorporates by reference the orbital debris mitigation discussion from the first-generation application proceeding.

ENGINEERING CERTIFICATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this application, and that it is complete and accurate to the best of my knowledge and belief.

/s/ Mihai Albulet

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Date