DENALI 20020, LLC

MODIFICATION APPLICATION

SES-MOD-20180619-01710

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I. INTRODUCTION

Denali 20020, LLC[1] ("Denali") requests modification of its earth station license, SES-MOD-20180619-01710, Call Sign (E990066), to add the "Servicer" satellite of the Astroscale Ltd.[2] ("Astroscale") ELSA-d system as a foreign point of communication[3] and support the 6-12 month mission. The ELSA-d mission seeks to demonstrate technology capable of providing reliable and cost-efficient spacecraft retrieval services to satellite operators, secure long-term spaceflight safety, and achieve orbital sustainability for the benefit of future generations.[4] Accordingly, grant of this application to support the ELSA-d mission is in the public interest.

The ELSA-d system, including the Servicer satellite, will use the following frequency bands: 2025-2100 MHz, 2200-2290 MHz, and 8450-8500 MHz. All the ground stations supporting the mission are identified below in Table 6.

II. ELSA-D SYSTEM DESCRIPTION

The ELSA-d mission will be a major step forward in demonstrating that Astroscale's technology is capable of rendezvous and proximity operations ("RPO"), capture, and removal of orbital debris. The ELSA-d mission, which is in its assembly, integration, and test stages and tentatively planned to be launched tentatively around July 2020, will demonstrate key technologies and procedures for the rendezvous, capture, and de-orbit of a piece of mock debris.

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[1] ATLAS Space Operations, Inc. has a contract with Denali 20020, LLC to operate an antenna in its Brewster, WA facility (Call Sign E990066) and a contract with Center for Southeastern Tropical Advanced Remote Sensing (C-Stars) to operate an antenna in its Miami, Florida facility in both cases to support the ELSA-d mission.

[2] Astroscale Ltd. is a UK registered company, and the ELSA-d system will be commanded and controlled from Harwell, England. *See* Annex A "ELSA-d CONOPS and Debris Mitigation Overview."

[3] This application requests authority to communicate with the Servicer satellite only. Viasat Inc. will seek authority to communicate with the Client satellite. For completeness, information regarding the entire ELSA-d system is provided in this application.

[4] Contemporaneously with this application, Denali is also submitting an application for Special Temporary Authority.

ELSA-d consists of two satellites, which are initially attached during launch: a "Servicer" satellite that will perform the RPO and capture and a "Client" satellite that will serve as a model piece of orbital debris but is in fact an active satellite.[5]

After launch and deployment, the two satellites will repeatedly separate and then dock in orbit, testing and showcasing different capabilities that will be applicable to the commercial market. The servicer satellite will be equipped with rendezvous guidance, navigation, and control technologies and a magnetic docking mechanism, and the client satellite will have a docking plate, which enables it to be captured by the magnetic docking mechanism.

a. Servicer Spacecraft

1. Radio System

The telecommunications system on the Servicer provides two main functions: telemetry and telecommand. The spacecraft telecommunications subsystem consists of a redundant set of S-band transponders (STRX-A and STRX-B) and an X-Band transmitter (XTX). Each transponder contains a receiver and a transmitter that will be used for uplinking platform telecommands and downloading housekeeping telemetry respectively. Additionally, the X-band transmitter (XTX) will be used for downlinking payload data.

The Servicer is equipped with two patch antennas (SANT-1R and SANT-2R) connected to both S-band receivers via a hybrid coupler and a divider, two patch antennas (SANT-1T and SANT-2T) connected to both S-band transmitters via a divider and a hybrid coupler as well, and one waveguide antenna with reflector (XANT-T1) connected to the X-band transmitter (XTX).

The four S-band antennas are distributed onto two sides of the spacecraft. The +Z side has the SANT-2R, SANT-2T, while the -Z side has the SANT-1R and SANT-1T.

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[5] *See* Section 1 of "ELSA-d CONOPS and Debris Mitigation Overview" for more detailed information on the Servicer and Client capabilities. In the UK license application filings, Astroscale uses the terms "chaser" and "target." However, Astroscale has since adopted the terms "servicer" and "client" in accordance with CONFERS Guiding Principles and uses those terms throughout this document although some graphics within this application may still display the previous naming convention. *See* Consortium for the Execution of Rendezvous and Servicing Operations (CONFERS) Guiding Principles, Nov 2018. https://www.satelliteconfers.org/wp-content/uploads/2018/11/CONFERS-Guiding-Principles_7Nov18.pdf.

The radiation pattern of both S-band antenna is hemispherical coverage, placed such that the zero degrees maximum gain is parallel to the plus and minus Z-axis. The X-band antennas is placed at the +Z side.

Figure 1: Location of X-Band Antennas on Servicer Spacecraft and Antenna Gain Patterns

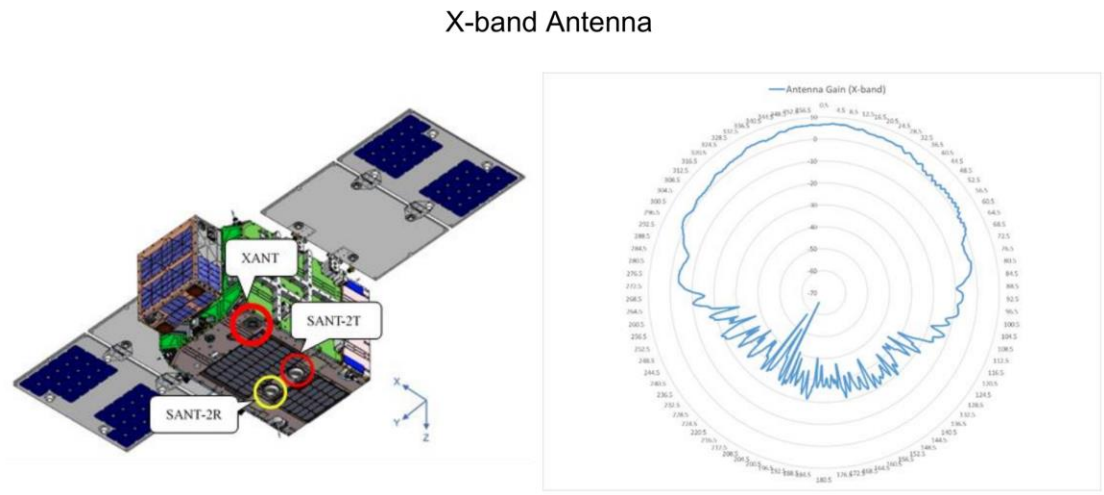
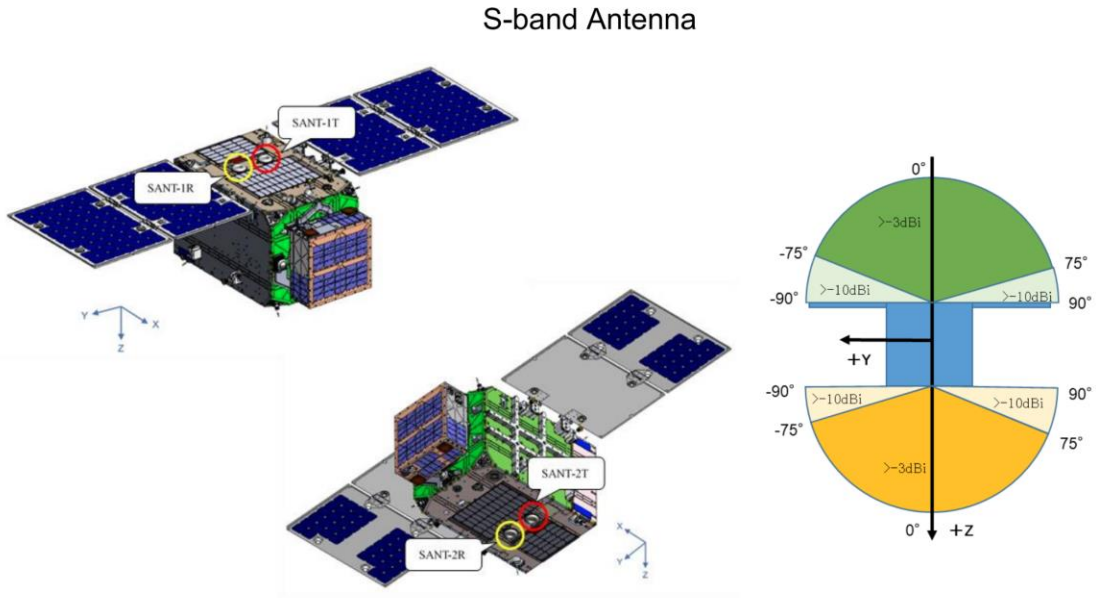


Figure 2: Location of S-Band Antennas on Servicer Spacecraft and Antenna Gain Patterns



2. Servicer S-Band Downlink Characteristics

The S-Band communication link between Servicer and a ground station will be established only when the local elevation angle (between the ground station and the Servicer) is equal to or greater than 5 degrees. The satellite will transmit real time Housekeeping Telemetry to the connected ground station. Also, if commanded, the satellite will downlink stored telemetry and/or on-board data. The data is transmitted using Consultative Committee for Space Data Systems ("CCSDS") Telemetry protocol.

Table 1: Summary of Main Parameters of S-Band Downlink for Servicer

Parameter	**Value**
Centre Frequency	2275 MHz
Bandwidth	461 kHz
RF Output Power	0.062 W (4kbps), 0.2 W (64 kbps)
Modulation	BPSK
Bit Rate	4000 bps, 64102 bps
Polarization	RHCP
Minimum G/T	12.6 dB/K
Antenna EIRP	-13.89 dBW (Transmitter Antenna Gain = -3 dB)

3. Servicer S-Band Uplink Characteristics

The S-Band communication link between the Servicer and a ground station will be established only when the local elevation angle (between the ground station and the Servicer) is equal to or greater than 5 degrees. Once the signal is acquired, the Mission Control Center ("MCC") will start sending telecommands to the Servicer. In order to establish the S-band uplink communication with Doppler effect, the ground stations should track the Carrier by sweeping the range of ± 170 kHz around 2095 MHz. The telecommands are transmitted using CCSDS telecommand protocol.

Table 2: Summary of Main Parameters of S-Band Uplink for Servicer

Parameter	**Value**
Centre Frequency	2095 MHz
Bandwidth	300 kHz
RF Output Power (Ground Station)	50.63 dBW
Modulation (Ground Station)	PSK/PM
Bit Rate	4000 bps
Polarization	RHCP
Minimum G/T	-39.4 dB/K
Antenna EIRP	50.63BW

4. Servicer X-Band Downlink Characteristics

The X-Band communication link between Servicer and a ground station will be established only when the local elevation angle (between the ground station and the Servicer) is equal to or greater than 5 degrees. The X-Band downlink will be used for transmitting imaging data to the MCC. The payload data will be downloaded as CCSDS frames and forwarded to Astroscale MCC as binary data. X-band frames should be stored at base-band equipment level and Astroscale will retrieve them ad-hoc. The X-Band downlink will also be used to downlink stored telemetry.

Table 3: Summary of Main Parameters of X-Band Downlink for Servicer

Parameter	**Value**
Centre Frequency	8470 MHz
Bandwidth	31 MHz
RF Output Power	variable +30 dBm to +39 dBm by 1dB step
Modulation	Filtered Offset-QPSK – BT 0.5
Bit Rate	8.33 Mbps
Polarization	RHCP
Minimum G/T	26.5 dB/K
Antenna EIRP	-0.99 dBW

b. Client Spacecraft[6]

1. Radio System

The Client telecommunications system provides two main functions: telemetry and telecommand. The Client sub-system comprises the S-band RF uplink and downlink. The system is fixed to the telemetry encoder and command decoder hardware. It has a distributed Controller Area Network (CAN-SU2) with programmable nodes for local telemetry encoding

[6] See *supra* note 2.

and command decoding. For redundancy purposes, the design consists of two hot redundant S-band Receivers and one S-band Low Rate Transmitter (LRTx). The two receivers and the LRTx will be connected to two antennas. The Client spacecraft does not have an X-band transmitter.

The Client spacecraft has two patch antennas (Rx) connected to both S-band receivers via a hybrid coupler, two patch antennas (Tx) connected to both S-band transmitters via a splitter. The four patch antennas are distributed onto two sides of the spacecraft. The +Z side has Earth facing receiver (Rx) and transmitter (Tx) patches, while the -Z side has Space facing receiver (Rx) and transmitter (Tx) patches.

Figure 3: Client Antenna Location Model

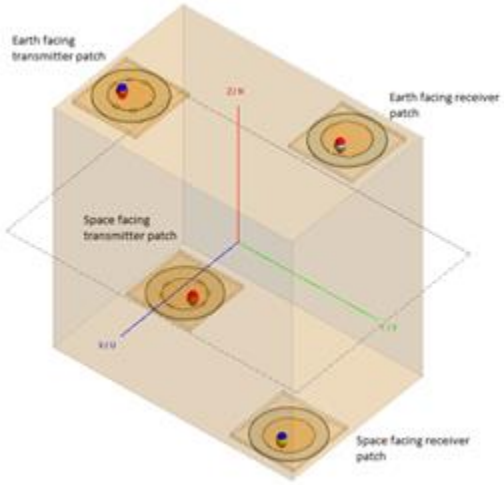


Figure 4: Client Uplink Antenna Pattern (Client Freeflight)

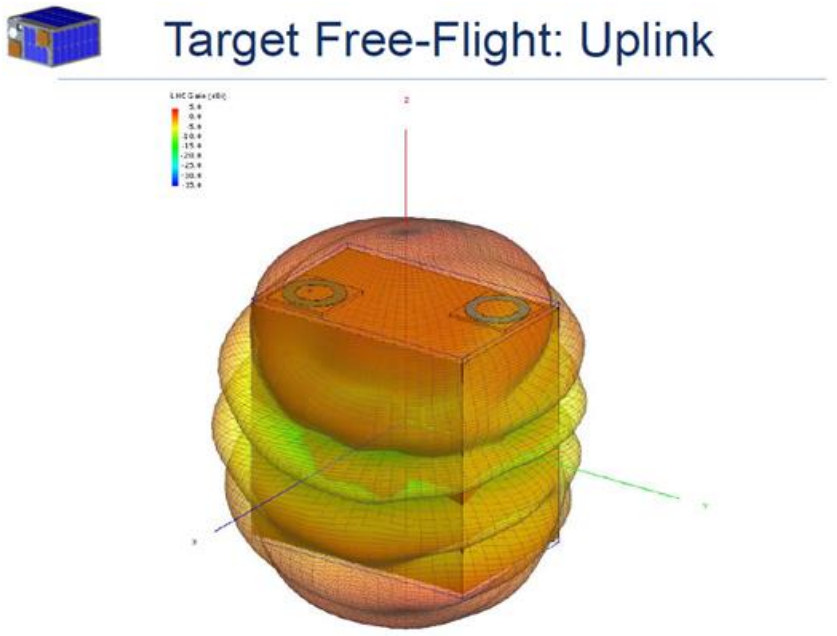


Figure 5: Client Uplink Antenna Pattern (Client-Servicer Attached)

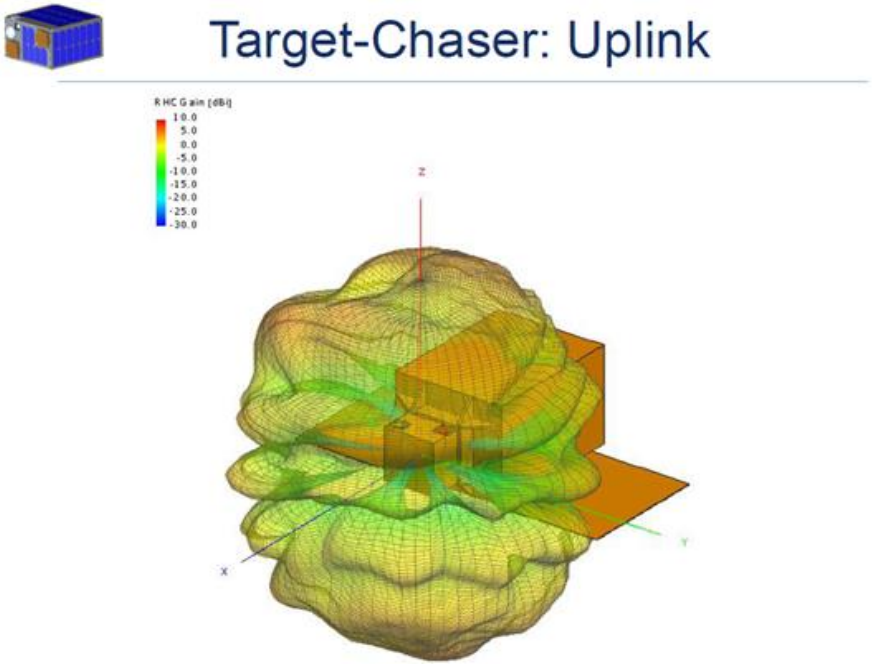


Figure 6: Client Downlink Antenna Pattern (Client Freeflight)

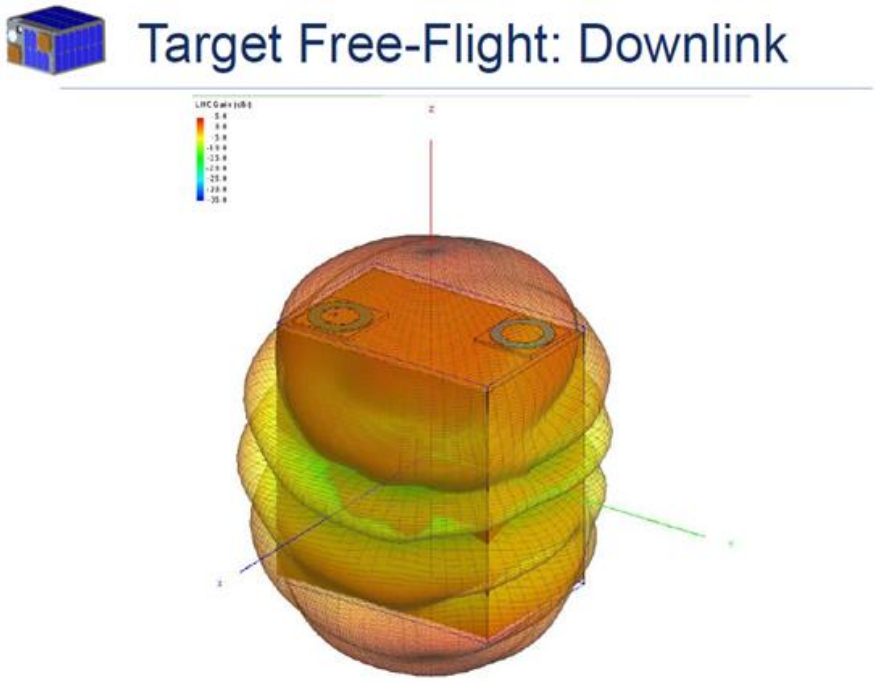
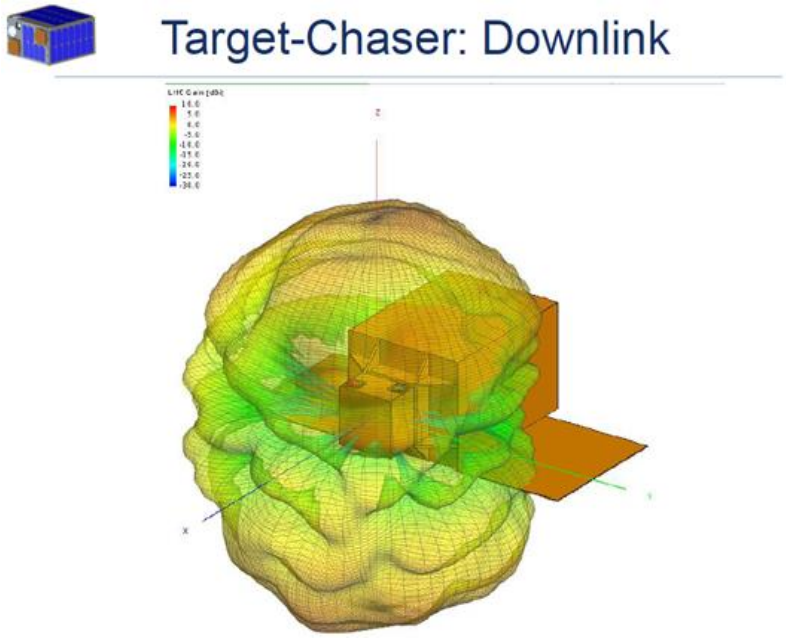


Figure 7: Client Downlink Antenna Pattern (Client-Servicer Attached)



2. S-Band Uplink Characteristics of the Client

The S-Band communication link between the Client and a ground station will be established only when the local elevation angle (between the ground station and the S/C) is equal to or greater than 5 degrees. The Telecommand uplink data rate chosen is 38.4 Kbps BPSK. The telecommands are transmitted using standard SSTL protocol.

Table 4: Summary of Main Parameters of S-Band Uplink for Client

Parameter	**Value**
Centre Frequency	2073 MHz
Bandwidth	300 kHz
RF Output Power (Ground Station)	36.8 dBW
Modulation (Ground Station)	BPSK
Bit Rate	38.4 Kbps
Polarization	RHCP
Minimum G/T	-38.7 dB/K
Antenna EIRP	45.0 dBW

3. S-Band Downlink Characteristics of the Client

The Client spacecraft will downlink payload data after successfully docking with the Servicer spacecraft. The S-Band communication link between the client and a ground station will be established only when the local elevation angle (between the ground station and the S/C) is equal to or greater than 5 degrees. The downlink data rate will be 38.4 Kbps or 115.2 Kbps QPSK with 1/2 rate convolutional encoding. The data is transmitted using the standard SSTL protocol.

Table 5: Summary of Main Parameters of S-Band Downlink for Client

Parameter	**Value**
Centre Frequency	2251 MHz
Bandwidth	460 kHz

RF Output Power	0.1 W
Modulation	QPSK (½ rate convolution)
Bit Rate	38.4 kbps or 115.2 kbps
Polarization	LHCP
Minimum G/T	12.1 dB/K
Antenna EIRP	-17.2 dBW (Transmitter Antenna Gain = -5.5 dB)

c. Frequency Coordination

The ELSA-d ITU filing has been submitted to the ITU by the Japan administration and was published on March 13, 2019. The latest publication by the ITU is API/B/1178 on October 29, 2019. Astroscale U.S. Inc., on behalf of Astroscale Ltd., has conducted pre-coordination meetings with U.S. stakeholders including: NASA Spectrum Management Program, FCC International Bureau, FCC Office of Engineering and Technology, NOAA Office of Radio Frequency Management, NTIA Office of Spectrum Management and the U.S. Air Force Spectrum Management Office.

d. Mission Timeline

The ELSA-d system is tentatively planned for launch around July 2020. The demonstration mission will occur in an orbit between 500 and 600 km altitude (with a nominally target orbit of 550 km), depending on the deployment altitude of the primary mission of the launch vehicle. The mission duration will be 6 -12 months with an expected duration of 6 months. For more information regarding the concepts of operations of the ELSA-d mission and subsequent debris mitigation and mission duration information, please see the attached annex to this application.[7]

[7] *See* Annex A: ELSA-d CONOPS and Debris Mitigation Overview

e. Servicer Ground Stations

Astroscale has contracted with various operators to support ELSA-d's Servicer and Client spacecraft. Each earth station is critical for mission operations. The full list of ground stations is provided in the tables below.

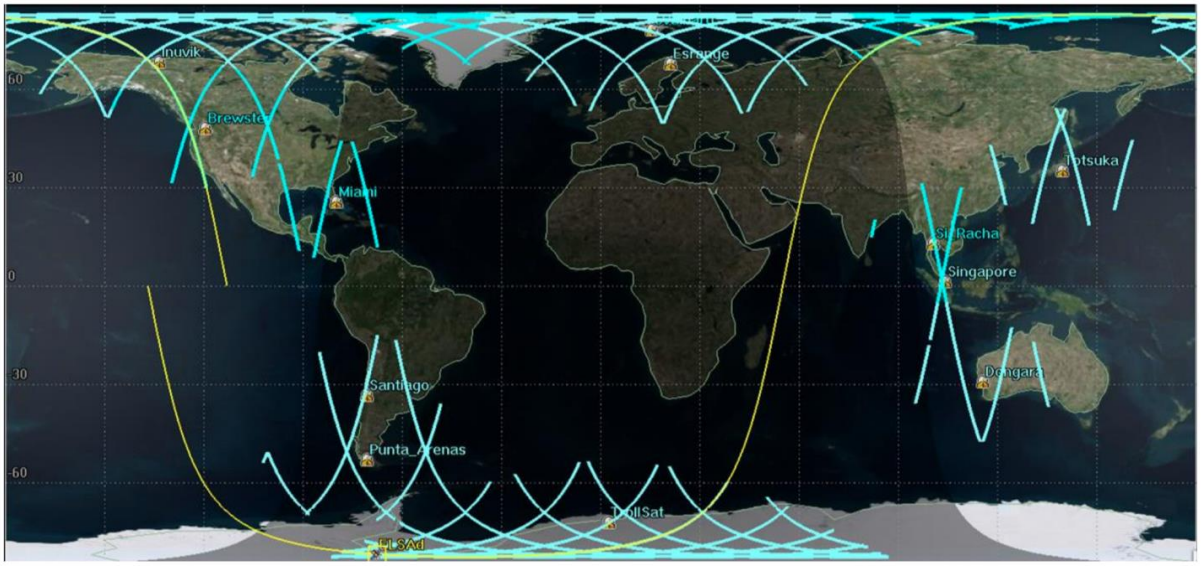
At a minimum, the Astroscale facility at Totsuka will provide 4 passes per day. However, the intention is to schedule one to two passes per day for routine Servicer operations. Critical operations may require the use of all available ground stations, which will be determined as part of mission planning prior to each operation.

Table 6: Servicer Ground Station List

Facility Owner	Operator	Station Name	Location (Lat./Long.)	Bands Supported	Frequency of Use
KSAT	KSAT	Svalbard	Longyearbyen, Norway Lat: 78.2316 Long: 15.377	S & X	LEOP, Critical Phases and On Demand for Routine
KSAT	KSAT	Troll	Queen Maud Land, Antarctica Lat: -72.0112 Long: 2.5536	S & X	Critical Phases
KSAT	KSAT	Singapore	Singapore Lat: 1.3962 Long: 103.8343	X	Critical Phases
SSC	SSC	Inuvik	Inuvik, Canada Lat: 68.2 Long: -133.3	S & X	Critical Phases
SSC	SSC	Esrange	Kiruna, Sweden Lat: 67.8833 Long: 21.0666	S & X	LEOP, Critical Phases and On Demand for Routine
SSC	SSC	Punta Arenas	Punta Arenas, Chile Lat: -52.936 Long: -70.87	S & X	Critical Phases

Facility Owner	Operator	Station Name	Location (Lat./Long.)	Bands Supported	Frequency of Use
SSC	SSC	Santiago	Santiago, Chile Lat: -33.1333 Long: -70.666	S & X	Critical Phases
SSC	SSC	Si Racha	Thailand Lat: 13.1737 Long: 100.9311	S & X	Critical Phases
SSC	SSC	Dongara	Perth, Australia Lat: -29.05 Long: 115.35	S & X	Critical Phases
C-Stars	ATLAS	Miami	Florida, US Lat: 25.734699 Long: -80.162201	S & X	Critical Phases
Denali	ATLAS	Brewster	Washington, US Lat: 48.14586 Long: -119.70128	S & X	Critical Phases
Astroscale	Astroscale	Totsuka	Yokohama, Japan Lat: 35.4051 Long: 139.5494	S & X	LEOP, Critical Phases and 4 passes day for Routine

Figure 8: Model of ELSA-d, Servicer, Orbit, and Global Transmissions



f. Client Ground Stations[8]

The following list identifies the Client ground station support. The intention is to schedule at least one pass per orbit for routine Client operations and use as many ground contacts as possible during critical phases.

Table 7: Client Ground Station List

Provider	Operator	Station Name	Location	Bands Supported	Used in Phase
Viasat	Viasat	Pendergrass	Georgia, USA	S Only	On Demand
Viasat	Viasat	Guildford	Surrey, UK	S Only	On Demand
Viasat	Viasat	Cordoba	Cordoba Province, Argentina	S Only	On Demand
Viasat	Viasat	Alice Springs	Northern Territory, Australia	S Only	On Demand

Figure 9: Model of ELSA-d, Client, Orbit, and Global Transmissions

[8] See *supra* note 2.

III. ELSA-D U.S. MARKET ACCESS

As a preliminary matter, the demonstrations associated with the ELSA-d mission are not intended to deliver commercial service to the United States. Thus, the filing requirements under Sections 25.114 and 25.137 should not apply, and Denali requests a waiver of those rules.[9] Nonetheless, to the extent that the Commission determines that those rules are applicable and a waiver is not warranted, Denali submits the following information in satisfaction of those requirements.

The Commission has an established framework for considering requests for non-U.S. licensed space stations to access the U.S. market. To be approved, a request to access the United States by a non-U.S. satellite system must be found to be in the public interest.[10] In evaluating the public interest benefit provided by allowing access to the U.S. market by a non-U.S. satellite system, the Commission considers: (i) the effect on competition in the United States; (ii) spectrum availability; (iii) eligibility and operational requirements; and (iv) national security, law enforcement, foreign policy, and trade considerations.[11] Parties seeking U.S. market access for non-U.S. licensed space stations also must provide the same information concerning legal and technical qualifications that applicants must provide for space station licenses issued by the Commission.[12]

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[9] *See, e.g.*, Application of Universal Space Network, Inc., File No. SES-STA-20190611-00777 (granted Aug. 7, 2019) (granting authority for earth station operator to communicate with a non-U.S.-licensed space station to conduct LEOP operations without the market access filing requirements under Sections 25.114 and 25.137); *see also* 47 C.F.R. § 1.3; *Ne. Cellular Tel. Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

[10] *Amendment of the Commission's Regulatory Policies to Allow Non-U.S. Licensed Space Stations to Provide Domestic and International Satellite Service in the United States*, Report and Order, 12 FCC Rcd 24094, ¶ 29 (1997) ("*DISCO II Order*"), *on reconsideration*, 15 FCC Rcd 7207, ¶ 5 (1999).

[11] *See id.*

[12] *See Amendment of the Commission's Space Station Licensing Rules and Policies; Mitigation of Orbital Debris*, First Report and Further Notice of Proposed Rulemaking in IB Docket No. 02-34, and First Report and Order in IB Docket No. 02-54, 18 FCC Rcd 10760, ¶ 288 (2003). Some of the Commission's application policies for authorizing non-U.S. licensed space stations are codified in Section 25.137 of the Commission's rules. *See* 47 C.F.R. § 25.137.

Denali's request for authority to communicate with the ELSA-d system from U.S. ground stations is supported by the considerations identified above, and thus, it is in the public interest to grant this application. In addition, as demonstrated below, Astroscale is legally and technically qualified.

a. Effect on Competition in the United States

An operator seeking access to the U.S. market for a non-U.S. licensed satellite system is entitled to a presumption in favor of U.S. market access if the operator is authorized by a World Trade Organization ("WTO") member country to provide satellite services covered by the WTO Basic Telecommunications Agreement (the "WTO Agreement").[13] As noted above, the ELSA-d satellite system will operate under an ITU filing submitted by the country of Japan and possess a mission license from the UK Space Agency. The operating entity, Astroscale Ltd., is a UK-registered company, and the parent company, Astroscale Holdings Inc., is incorporated in Japan. Both Japan and the UK are members of the WTO.[14] In addition, the communications services associated with the ELSA-d mission are not excluded by the WTO Agreement.[15] Astroscale is thus entitled to a presumption that market entry for the ELSA-d system will satisfy the competition component of the public interest analysis and is not required to make an effective competitive opportunities showing.[16]

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[13] *DISCO II Order* at ¶ 39 ("We adopt our proposal to apply a presumption in favor of entry in considering applications to access non-U.S. satellites licensed by WTO Members to provide services covered by the U.S. commitments under the WTO Basic Telecom Agreement. Specifically, we will presume that satellite systems licensed by WTO Members providing WTO-covered services satisfy the competition component of the public interest analysis.").

[14] The Commission treats the United Kingdom as members of the WTO. *See, e.g.*, *Intelsat Holdings, Ltd., Transferor, and Serafina Holdings Limited, Transferee, Consolidated Application for Consent to Transfer Control of Holders of Title II and Title III Authorizations*, Memorandum Opinion and Order, 22 FCC Rcd 22151, ¶ 25, n.57 (2007).

[15] The following services are excluded by the WTO Agreement: direct-to-home; Digital Audio Radio Service; and Direct Broadcast Satellite Service. *See* General Agreement on Trade in Services, Fourth Protocol to the General Agreement on Trade in Services (Apr. 30, 1996), 36 I.L.M. 336 (1997).

[16] *See* 47 C.F.R. § 25.137(a)(2).

b. Spectrum Availability

The Commission also considers spectrum availability as a factor in determining whether grant of authorization to a foreign-licensed satellite is in the public interest.[17] In doing so, the Commission evaluates whether grant of access would create the potential for harmful interference with U.S.-licensed satellite and terrestrial systems. As discussed in Section IV, given the limited use of the frequencies during the short duration of the mission and Astroscale's coordination effort with incumbent operations, the ELSA-d system will not likely cause harmful interference to other authorized users. Granting U.S. market access for the ELSA-d system, therefore, would be consistent with the Commission's spectrum availability policies for non-U.S. licensed satellites.

c. National Security, Law Enforcement, Foreign Policy, and Trade Issues

The Commission has stated that the issues of national security, law enforcement, foreign policy, and trade, which it considers in evaluating requests for market access for non-U.S. licensed satellites, are likely to arise only in "rare circumstances."[18] Further, the Commission defers to the expertise of the Executive Branch in identifying and interpreting issues of this nature.[19] Denali's request to communicate with the ESLA-d system raises no such issues. Thus, this element of the Commission's *DISCO II Order* public interest analysis is satisfied.

d. Eligibility and Operational Requirements

Under Section 25.137 of the Commission's rules, the foreign-licensed operator seeking U.S. market access must provide the legal and technical information for the non-U.S. licensed

[17] *DISCO II Order* at ¶ 149 ("We adopt our proposal to consider spectrum availability as a factor in determining whether allowing a foreign satellite to serve the United States is in the public interest.").

[18] *Id.* at ¶ 180 ("We emphasize, however, that we expect national security, law enforcement, foreign policy and trade policy concerns to be raised only in very rare circumstances. Contrary to the fears of some commenters, the scope of concerns that the Executive Branch will raise in the context of applications for earth station licenses is narrow and well defined.").

[19] *Id*.

space stations required by Part 25 of the Commission's rules, including Section 25.114.[20] The information set forth in this legal narrative, the ELSA-d CONOPS and Debris Mitigation Overview, and the accompanying FCC Form 312 demonstrates compliance with the requirements of Section 25.137 and the other applicable sections of Part 25 of the Commission's rules.

Denali highlights here Astroscale's compliance with Section 25.114(d)(14)(v) of the Commission's rules, which states that, "[f]or non-U.S.-licensed space stations, the requirement to describe the design and operational strategies to minimize orbital debris risk can be satisfied by demonstrating that debris mitigation plans for the space station(s) for which U.S. market access is requested are subject to direct and effective regulatory oversight by the national licensing authority."[21] Because Astroscale is seeking a mission license from the UK Space Agency, the ELSA-d system will be subject to direct and effective regulatory oversight by that agency. Nonetheless, to facilitate the FCC's processing of this application, Denali has provided in an attachment[22] a summary of the information provided to the UK Space Agency to demonstrate that the debris mitigation plans associated with the ELSA-d mission are consistent with the FCC's rules.[23]

[20] *See* 47 C.F.R. § 25.137(b); *see also DISCO II Order* at ¶ 189.

[21] *Id*. § 25.114(d)(14)(v).

[22] *See* ELSA-d CONOPS and Debris Mitigation Overview attached.

[23] The Commission has stated in prior grants for U.S. market access that systems subject to direct and effective regulation by the United Kingdom concerning orbital debris mitigation are not required to provide an orbital debris mitigation showing. *See, e.g.*, Petition for Declaratory Ruling of O3b Limited Granting Access to the U.S. Market for the O3b MEO Satellite System, File No. SAT-AMD-20150115-00004, Grant, at 3, Condition 15 (granted Jan. 22, 2015); *WorldVu Satellites Limited Petition for a Declaratory Ruling Granting Access to the U.S. Market for the OneWeb NGSO FSS System*, Order and Declaratory Ruling, 32 FCC Rcd 5366, ¶ 25 (2017).

IV. WAIVER REQUEST - U.S. TABLE OF FREQUENCY ALLOCATIONS

a. 2025-2110 MHz (Earth-to-Space) TT&C Uplink

This band is allocated to Space Operations and Earth-Exploration Satellites Services ("EESS"), *inter alia*, in all ITU regions.[24] Astroscale expects the Japan administration to authorize use of this band for the ELSA-d mission under the Space Operations Service. In the United States, Space Operations Services are limited to federal operators, and EESS use by commercial operators is subject to conditions as may be applied on a case-by-case basis and the limitation that any use may not cause harmful interference to authorized operations.[25] Astroscale plans to communicate with the ELSA-d satellites from/to ground stations in the United States and internationally for the demonstration mission. Accordingly, to the extent necessary, Denali requests a waiver of the U.S. Table of Frequency Allocations to permit such communications using the 2025-2110 MHz band (Earth-to-space) for TT&C. Given the limited use of the frequencies during the brief duration of the demonstration mission, the commitment to coordinate use of these frequencies, and the public interest benefits supporting the mission, the potential for harmful interference is minimal and a waiver is warranted.[26]

b. 2200-2290 MHz (Space-to-Earth) TT&C Downlink

This band is allocated to Space Operations Services and EESS, *inter alia*, in all ITU regions.[27] Astroscale expects the Japan administration to authorize use of this band for the ELSA-d mission under the Space Operations Service. In the U.S., this band is allocated only for Federal use.[28] Astroscale plans to communicate with the ELSA-d satellites from/to ground stations in the United States and internationally for the demonstration mission. Accordingly,

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[24] *See* 47 C.F.R. § 2.106.

[25] *See* 47 C.F.R. § 2.106, n.US347.

[26] *See, e.g.*, Application of Spaceflight, Inc., IBFS File No. SAT-STA-20180523-00042 (granted Oct. 12, 2018); Application of Spaceflight, Inc., IBFS File No. SAT-STA-20150821-00060 (granted Oct. 26, 2016).

[27] *See* 47 C.F.R. § 2.106.

[28] *See* 47 C.F.R. § 2.106, nn.5.392, US303.

Denali requests a waiver of the U.S. Table of Frequency Allocations to permit such communications using the 2200-2290 MHz (space-to-Earth) downlink for TT&C. Given the limited use of the frequencies during the brief duration of the demonstration mission, the commitment to coordinate use of these frequencies, and the public interest benefits supporting the mission, the potential for harmful interference is minimal and a waiver is warranted.[29]

c. 8450-8500 MHz (Space-to-Earth) TT&C and Data Downlink

This band is allocated to Fixed, Mobile, and Space Research Services in all ITU regions.[30] Astroscale expects the Japan administration to authorize the use of this band for the ELSA-d mission under the Space Research Service. In the U.S., the band is allocated to Space Research Services for all operators and to Fixed Services for Federal operators.[31] Astroscale plans to communicate with the ELSA-d satellites from/to ground stations in the United States and internationally for the demonstration mission. Accordingly, to the extent necessary, Denali requests a waiver of the U.S. Table of Frequency Allocations to permit such communications using the 8450-8500 MHz (Space-to-Earth) downlink for TT&C and the transmission of imaging data to facilitate its RPO activities. Given the limited use of the frequencies during the brief duration of the demonstration mission, the commitment to coordinate use of these frequencies, and the public interest benefits supporting the mission, the potential for harmful interference is minimal and a waiver is warranted.[32]

[29] *See supra* note 3.

[30] *See* 47 C.F.R. § 2.106.

[31] *See id.*

[32] *See supra* note 3.

V. CONCLUSION

For the foregoing reasons and those stated in the accompanying materials, Denali requests that the Commission grant this application.