

**APPLICATION REQUIREMENTS UNDER SECTIONS 25.114 AND 25.137
OF THE RULES FOR EARTH STATIONS SEEKING TO COMMUNICATE WITH
NON-U.S. LICENSED SPACE STATIONS
(AMONG OTHER WAIVER REQUESTS AND CONSIDERATIONS)¹**

By this application ("Application"), SSC Space US, Inc. (a/k/a Universal Space Network, Inc.) (the "Applicant") a Delaware corporation, hereby respectfully seeks FCC approval for a new satellite earth station license for a fixed earth station facility in Naalehu (South Point), Hawaii (the "Earth Station") that proposes to provide transmit/receive services to a non-U.S. licensed space station system (Chandrayaan-2) as a point of communication. Specifically, the Applicant requests Commission approval to use the Earth Station as one of multiple earth stations around the Earth that is providing Telemetry, Tracking and Command ("TT&C") capabilities (via S-band uplink and downlink frequencies) and a receive-only data downlink (via X-band frequencies) with respect to space station Chandrayaan-2 ("Chandrayaan-2" or the "Satellite"), which is a lunar orbiting spacecraft developed and run by the Indian Space Research Organisation ("ISRO" or "Owner").² Technical information relating to the proposed earth station is provided in the application and its attachments, including FCC Form 312 and Schedule S, based on information provided by the Owner or otherwise known to the Applicant.

I. BACKGROUND and REQUEST FOR WAIVERS

A. Background. The Applicant has a long history and extensive expertise in providing and developing satellite communications for U.S. government agencies, including the National Aeronautical and Space Administration ("NASA") and the U.S. Department of Defense, as well as other scientific research and commercial services. For example, the Applicant (and its affiliated entities) serve a critical role in NASA's Near Space Network, using its U.S.-based earth stations in South Point, Hawaii, and North Pole, Alaska, among other locations, to support NASA's ongoing efforts.³ Other examples include the Applicant's ongoing

¹ To the extent necessary for proposed communications with a non-U.S. lunar satellite, the Applicant requests that this exhibit also be treated as a petition for declaratory ruling consistent with the FCC requirements for this sort of earth station application.

² Because the Satellite is in lunar orbit, information provided in this Application, including on Schedule S, with respect to the orbit addresses the Satellite's orbit of the Moon, not of Earth. The International Bureau has previously approved requests for temporary authorization from the Applicant in other recent lunar matters. *See, e.g.*, FCC File No. SES-STA-20180910-02633 (approving Applicant's temporary provision of certain services to mission of Israeli lunar lander).

³ *See, e.g.*, National Aeronautical and Space Administration, "Where are the NSN Complexes Located?" (available at: https://www.nasa.gov/directorates/heo/scan/services/networks/near_space_network/complexes (March 3, 2021) (last viewed on November 18, 2021)). This Near Space Network thus similarly relies on the Earth Station, which transmits and receives using S-band and X-band frequencies. *See* NASA, "Tracking and Data Relay Satellite (TDRS)", https://www.nasa.gov/directorates/heo/scan/services/networks/tdrs_main (last viewed on November 18, 2021) ("TDRS comprises the space segment of the government-owned portion of the Near Space Network.")

support for the NASA Lunar Reconnaissance Orbiter as well as the NASA Lunar Artemis program that seeks to land humans safely on the moon in the next few years. These efforts by the Applicant are consistent with and generally further the goals of NASA to increase its use of commercial network assets to meet its own mission needs.⁴

In addition to this work for U.S. government agencies, the Applicant and its affiliated entities routinely provide earth station services from locations around the Earth for other government and commercial space missions. To this end, the Applicant has held many temporary or other authorizations from the Federal Communications Commission for earth station operations.⁵

Specifically, the current request supports ongoing scientific research and other operations of Chandrayaan-2. Among other equipment, the Satellite houses the (i) Chandrayaan-2 Large Area Soft X-ray Spectrometer; (ii) Solar X-ray Monitor; (iii) Chandra's Atmospheric Compositional Explorer 2; (iv) Dual Frequency Synthetic Aperture Radar; (v) Imaging Infra-Red Spectrometer; (vi) Terrain Mapping Camera; and (vii) Orbiter High Resolution Camera.⁶ Below is an image of the Satellite with this equipment:⁷

⁴ See, e.g., National Aeronautical and Space Administration, "Near Space Network" (available at: https://www.nasa.gov/directorates/heo/scan/services/networks/near_space_network (highlighting "SCaN's effort to incorporate increasing levels of commercial service while ensuring mission needs are met") (last viewed on November 18, 2021).

⁵ See, e.g., FCC File Nos. SES-STA-20190611-00007 (granting temporary authorization to support TT&C operations from Hawaii earth station for European-licensed EDRS-C); SES-STA-20180305-00189; SES-STA-20180220-00153; SES-STA-20171204-01297; SES-STA-20170131-00105; SES-STA-20161206-00933. The Applicant also has held earth station licenses for other operations, including TT&C and Earth Exploration/Observation Satellite Services ("EEOSS") operations. See, e.g., FCC File No. SES-MOD-20180424-00394 (adding point of contact and new frequencies to services provided to GEOEYE-1)

⁶ See, e.g., "Chandrayaan-2 orbiter payloads made discovery-class findings, says ISRO", ECONOMIC TIMES (English Edition) (as updated on Sept. 10, 2021) (available at <https://economictimes.indiatimes.com/news/science/chandrayaan-2-orbiter-payloads-made-discovery-class-findings-says-isro/articleshow/86089968.cms?from=mdr>) (most recently viewed November 3, 2021).

⁷ See, e.g., ISRO, HANDBOOK OF CHANDRAYAAN-2: PAYLOADS, DATA & SCIENCE AT 4 (available at https://www.isro.gov.in/sites/default/files/article-files/node/16338/hand_book_-_payloads_data_and_science.pdf) (most recently viewed on November 3, 2021) ("Chandrayaan-2 Handbook").

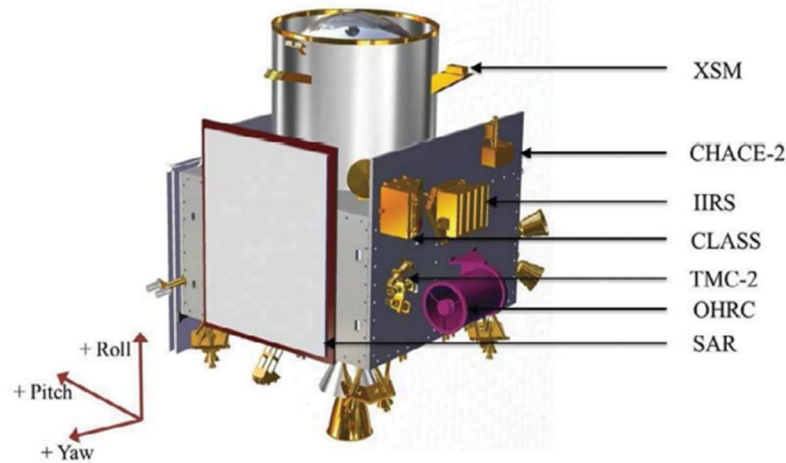


Figure 1.3: Chandrayaan-2 Orbiter Craft Payloads.

The Satellite, which has been in orbit of the Moon since August 2019, is part of a mission that is expected to provide information and other services important to the United States' own projected return to the Moon with a crewed mission ("Artemis Program" or "Artemis"). Specifically, under Article 5 of the Implementing Arrangement between NASA and ISRO regarding the Satellite, NASA and ISRO agree, that with respect to Chandrayaan-2, they will have "access to and use of all data generated," and that data "shall be made available for public access as soon as practicable and consistent with good scientific practice."⁸ To that end, the "payloads on the orbiter [i.e., the Satellite] will collect scientific information on lunar topography, mineralogy, elemental abundance, and the lunar exosphere, and signatures of hydroxyl and water-ice."⁹ Accordingly, ongoing support of the Satellite's mission, which is currently expected to last for several more years, advances the public interest, including that of the United States, by providing crucial information in support of NASA's Artemis mission.

As further confirmation of these expected scientific and other benefits, the Satellite's ongoing mission already is expanding the world's relatively limited knowledge of the Moon's south polar region, which is an area of the Moon that is intended to be a current focus of NASA's upcoming Artemis mission (as well as potentially relevant to future lunar commercial ventures in

⁸ Implementing Arrangement between the Indian Space Research Organisation of the Republic of India and the National Aeronautics and Space Administration of the United States of America for Cooperation of the Chandrayaan-2 Mission, at Article 5 (2019) (available at <https://www.mea.gov.in/Portal/LegalTreatiesDoc/US19B3558-1.pdf>) (most recently viewed on Nov. 3, 2021) (the "Chandrayaan-2 Implementing Agreement" or "Implementing Agreement"). By its terms, the Agreement is to last six years from February 11, 2019, though the data access provisions will endure even after expiration of the agreement. *See id.* at Article 13.

⁹ *See id.* at Article 1.

light of the expected availability of ice and water in that region).¹⁰ Among other publicly released discoveries to date, the findings of this Satellite include:¹¹

- the variability of the Argon-40 at the middle and higher latitudes of the Moon;
- at least trace amounts of chromium and manganese on the lunar surface;
- indicia of hydroxyl and water-ice on the lunar surface, including "the first-ever unambiguous detection of the hydration features of the Moon;" and
- "signatures of . . . sub-surface water-ice" and "high resolution mapping of the lunar morphological features in the polar regions."

In light of the sharing of essential data regarding ice and other lunar resources and terrain with NASA and the public generally, support of the ongoing mission with an FCC-licensed earth station clearly is consistent with the public interest. Indeed, the FCC already has granted a number of authorizations for the Applicant to support this publicly beneficial mission.¹² In light of the expected duration of the mission (including the term of the Chandrayaan-2 Agreement), the Applicant now seeks to obtain a more permanent license to operate the Earth Station in a manner consistent with the Application.

B. Waiver Requests. Grant of the proposed Application, including any waivers required, is consistent with the public interest. Per Section 1.3 of the Commission's Rules, the Commission may grant a waiver for good cause shown.¹³ Under that long-established principle, the Commission has waived several earth station requirements in cases in which the Applicant

¹⁰ See, e.g., Kunal Gaurav, "Why has Nasa chosen the Nobile Crater of Moon's south pole as Viper's landing site?", HINDUSTAN TIMES (as updated on September 21, 2021) (available at <https://www.hindustantimes.com/science/why-has-nasa-chosen-the-nobile-crater-of-moon-s-south-pole-for-viper-s-landing-101632219578425.html>) (most recently viewed Nov. 3, 2021); NASA's Lunar Exploration Program Overview (September 2020) (available at https://www.nasa.gov/sites/default/files/atoms/files/artemis_plan-20200921.pdf) (most recently viewed Nov. 3, 2021) ("Artemis Plan") ("At the lunar South Pole, NASA and its partners will develop an Artemis Base Camp to support longer expeditions on the lunar surface. Planned Base Camp elements include a lunar terrain vehicle (LTV, or unpressurized rover), a habitable mobility platform (pressurized rover), a lunar foundation habitation module, power systems, a[n]d in-situ resource utilization systems.")

¹¹ See, e.g., "Chandrayaan-2 orbiter payloads made discovery-class findings, says ISRO", ECONOMIC TIMES (English Edition) (as updated on Sept. 10, 2021) (available at <https://economictimes.indiatimes.com/news/science/chandrayaan-2-orbiter-payloads-made-discovery-class-findings-says-isro/articleshow/86089968.cms?from=mdr>) (most recently viewed November 3, 2021).

¹² See, e.g., FCC File Nos. SES-STA-20201125-01271 and SES-STA-20210309-00457 (for authorization to conduct receive-only operations) as well as File No. SES-STA-20210505-00771 (authorizing telecommand for a lunar eclipse event). Additional STA requests have been or will be filed as needed to support similar operations during the pendency of this application.

¹³ 47 C.F.R. § 1.3.

intends to provide only limited earth-station services, including TT&C services, among other considerations.¹⁴

Similarly, though the Commission may typically require an extensive showing before authorizing an earth station to provide services to a non-U.S. licensed space station that has not been previously authorized within the United States,¹⁵ the nature of the services to be provided in this unusual case justifies waivers of aspects of Sections 25.114 and 25.137 of the Commission's Rules for at least the following reasons:

1. The Applicant is currently proposing to provide only TT&C and a single data-downlink service to an existing lunar satellite through the Earth Station.¹⁶ In past rulings, TT&C services have required a lesser showing under Section 25.137 of the Commission's Rules.¹⁷ In addition, the public safety benefits of such TT&C services further justify a lesser showing for a request by U.S. earth stations to offer these services. These limited TT&C services, along with the requested data downlink, pose no real risk of material interference, as demonstrated by the attached frequency coordination report,¹⁸ and thus should not be subject to the extensive requirements imposed on other market access petitions.
2. Because the proposed earth station services are for a satellite already in lunar orbit, the services to be provided should not be subject to all the existing regulations established for services to spacecraft orbiting or launching from Earth. For example, in a recent order,

¹⁴ See, e.g., FCC File No. SES-STA-20190611-007 (granting temporary authorization to support TT&C operations for the European-licensed EDRS-C).

¹⁵ See *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 (1997) (“DISCO II Order”).

¹⁶ The Commission generally classifies TT&C as a space operation service, which is “a radiocommunication service concerned exclusively with the operation of spacecraft, in particular space tracking, space telemetry, and space telecommand.” 47 C.F.R. § 2.1; ITU R.R. 1.23. These three operations commonly continue to be referred to as “TT&C.”

¹⁷ See, e.g., *U.S. Electrodynamics, Inc.*, Order and Authorization, File Nos. SES-LIC-1999021200165, et al., (IB rel. June 24, 1999) (approving five earth stations to provide TT&C to mobile satellite system pursuant to authority of the United Kingdom without extensive DISCO II showing). Technical information is also being provided in this application only for the frequency bands for which authority is being sought with respect to services being provided via the United States: to wit, the two pairs of S-band frequencies specified for TT&C as well as the specific frequency for the proposed data downlink.. See, e.g., *Telesat Canada*, IBFS File No. SAT-PPL-200605016-00061, at 1 n.2 (filed May 16, 2006; granted Jan. 18, 2007); see also *Establishment of Policies and Service Rules for the Mobile Satellite Service in the 2 GHz Band*, Report and Order, 15 FCC Rcd 16127 (¶ 86) (2000) (clarifying that market access application requirements apply only to relevant system capabilities for communications to or from the United States, and not to system capabilities for communications wholly outside of the United States).

¹⁸ Comsearch Frequency Coordination Report (dated May 19, 2021) (attached as Attachment 2) (“Attachment 2”).

the Commission sensibly concluded that "it is appropriate to exempt small spacecraft with planned non-Earth orbiting missions from several of the certifications required for most applicants under the streamlined process and make modifications to others."¹⁹ Moreover, in a 2020 order on debris mitigation, the Commission expressly declined to establish any "regulations specific to lunar and other orbits . . . particularly as they relate to satellite disposal."²⁰ The Commission should similarly not unnecessarily apply other technical regulations designed for Earth-orbiting space stations to the Satellite or the Earth Station.

3. Because the Satellite is, at this point, an exclusively lunar mission, it is not clear to what extent Commission regulations concerned with market access petitions should be read to apply. Section 25.137(a) of the Commission's Rules is directed at situations when a non-U.S. licensed satellite will "serve the United States."²¹ As a lunar mission, the proposed services will not provide any direct support to any commercial or private entity, and so a market access petition would seem irrelevant. Moreover, ISRC has an Implementing Agreement with NASA, so that any relevant data from the Satellite's mission would seem likely to ultimately benefit the U.S. public via NASA. At the very least, approving this proposed service will ensure that at least one U.S.-based earth station will have an opportunity to be involved in this orbital support. Accordingly, the Commission should not strictly apply these requirements (including those of Section 25.114) to this request.
4. As the services to be provided are to provide assistance to a Satellite that has agreed to support an upcoming crewed mission for NASA, the Commission in turn should do what it can to support the Satellite's ongoing mission. Accordingly, given these unusual circumstances, and as necessary in light of the above, the Commission should be willing to waive requirements of its rules in order to approve the proposed authorization.
5. Finally, neither the Applicant nor any corporate parent, affiliate or subsidiary of the Applicant owns or controls the Satellite, which already is in lunar orbit. Because the Applicant does not own the Satellite, the Commission should not subject the Applicant's request to provide earth station services to the same level of scrutiny necessary for an applicant that owns and intends to operate a new (and not yet launched) satellite.

Among other circumstances, good cause for a Commission waiver of its rules exists if "special circumstances warrant a deviation from the general rule and such deviation will serve the public

¹⁹ *Streamlining Licensing Procedures for Small Satellites*, Report and Order, IB Docket No. 18-86, 34 FCC Rcd 13077, 13101 (¶ 66) (2019) ("*Small Satellites Order*").

²⁰ *Mitigation of Orbital Debris in the New Space Age*, Report and Order, IB Docket No. 18-313, 35 FCC Rcd 4156, 4223 (¶ 146) (2020). That order suggested the Commission might ask operators for more limited information regarding these issues, though it is not clear if even that expectation would apply to an earth station seeking to provide TT&C and downlink services to a non-U.S. lunar orbiter that it does not own or operate.

²¹ 47 C.F.R. § 25.137.

interest” better than adherence to the general rule.²² Since the market access analysis set forth in Section 25.137 was intended to ensure that U.S. licensed spacecraft have access to "effective competitive opportunities," and the existing lunar Satellite is not a commercial competitor to U.S. satellites of the Earth, requiring an extensive market access showing would seem to serve little purpose with respect to a U.S. earth station's additional support of an ongoing lunar mission. Accordingly, in light of these reasons and the clear public interest benefits to NASA and the public of supporting the current mission of the Satellite, the general requirements common to licensing an earth station to support a non-U.S. satellite should be waived to the extent necessary and the request approved.

Nonetheless, in order to facilitate Commission review of the proposed Earth Station services, and to the extent the Owner has provided the Applicant information relevant to Sections 25.114 and 25.137 of the Commission’s Rules, the Applicant also is respectfully submitting materials that further address various Sections 25.114 and 25.137 requirements for earth stations operating with non-U.S. licensed space stations, including:

- Section II of this exhibit describes how the proposed data downlink and TT&C services being provided to the Satellite through a license authorization are consistent with the policies underlying the Commission's *DISCO II Order*.
- Section III provides legal and technical information, respectively, for the Satellite pursuant to Part 25 of the Commission’s Rules.
- Section IV addresses certain application processing issues and requests that the Commission grant this application on a timely basis.
- Section V summarizes several public interest considerations supporting grant of this application.

II. *DISCO II* ANALYSIS

The Commission considers requests by earth station licensees to communicate with non-U.S. licensed satellites pursuant to several factors established in the *DISCO II Order*, including the effect on competition in the United States, eligibility and operating requirements, spectrum availability, and national security concerns.²³ As part of *DISCO II*, the Commission adopted an open-entry standard for applicants seeking to access satellite systems licensed by World Trade Organization (“WTO”) Members to provide satellite services covered by the U.S. commitments under the WTO Basic Telecom Agreement. Accordingly, the Commission established a

²² *Northeast Cellular Telephone Co. v. FCC*, 897 F.2d 1166 (D.C. Cir. 1990); see *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

²³ See, e.g., *Space Imaging, LLC*, Declaratory Order and Order and Authorization, 20 FCC Rcd 11964 (¶¶ 13-14) (IB 2005) (“*Space Imaging Order*”).

rebuttable presumption that entry of satellite systems licensed by WTO Members providing WTO-covered services will promote competition.²⁴

Permitting the Earth Station to provide TT&C and data downlink services to the Satellite satisfies applicable Commission's *DISCO II* requirements, including the following:

- India, which has authorized the Satellite, has been a member of the World Trade Organization since 1995.²⁵
- The United States did not appear to exclude services such as Space Operations (including TT&C) or Space Research from its commitments under the WTO Basic Telecom Agreement.²⁶ Thus, the *DISCO II Order's* presumption in favor of entry should apply to the provision of these services by the Earth Station to the Satellite.
- The proposed use of the Earth Station will contribute to the diversification of the client base of U.S.-located earth station facilities. Specifically, by increasing the potential customers of U.S.-based earth stations, including the Earth Station, the proposed service will strengthen U.S.-licensed earth stations, which will in turn foster competition and new services within the United States. In addition, the proposed authorization will benefit and support increased operations of the relevant Earth Station itself.

²⁴ See *DISCO II Order*, 12 FCC Rcd at 24112 (¶ 39).

²⁵ See, e.g., https://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm#collapseI (showing India as WTO member since January 1995) (last viewed January 19, 2022).

²⁶ As a general matter, U.S. commitments under the WTO Basic Telecom Agreement have been understood to include all manner of satellite services except for Direct Broadcast Satellite ("DBS") services, Direct-to-Home ("DTH") services, and Digital Audio Radio Services ("DARS"). See, e.g., *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*, First Order on Reconsideration, 15 FCC Rcd 7207, 7211 (¶ 8) (1999) (noting that ECO-SAT showing is required only for "[a]pplications to provide DTH, DBS, and DARS" for satellite systems from WTO member countries); 47 C.F.R. § 27.137(a). Accordingly, Space Research efforts, such as those pursued by the Satellite, should qualify for *DISCO II* treatment. (Per Section 2.1 of the Commission's Rules, "space research" includes a "radiocommunication service in which spacecraft or other objects in space are used for scientific or technological research purposes.") To the extent relevant, EESS also has been deemed within the *DISCO II* presumption. See, e.g., *Space Imaging Order*, 20 FCC Rcd 11964. Consistent with Section 2.1 of the Commission's Rules, EESS includes any radiocommunication service between earth stations and one or more space stations, in which "information relating to the characteristics of the Earth and its natural phenomena, including data relating to the state of the environment, is obtained from active sensors or passive sensors on Earth satellites," among other matters. In this case, the concept implicit in the EESS definition may be applied equally to lunar missions that perform terrain mapping and other services analogous to traditional EESS, as in this matter.

- The proposed operations will assist with greater safety in space operations generally by providing additional redundancy and support for the Satellite's TT&C functions.
- The proposed technical operations intend to be consistent with Commission's requirements or appropriate waivers.
- The required spectrum use within the United States will be limited, and appropriate for all proposed uses in this particular case as further set forth in this Application.

Finally, the proposed Satellite or Earth Station operations should not pose any national security, law enforcement, foreign policy, or trade concerns.²⁷ Indeed, as noted, NASA has entered into an arrangement to share data delivered by the Satellite, including that to be delivered to the Earth Station.²⁸

III. LEGAL AND TECHNICAL INFORMATION

Section 25.137(b) of the rules requires earth station applicants proposing to operate with non-U.S. licensed space stations to provide legal information for the non-licensed satellite in accordance with Part 25 of the rules. To the extent that rule arguably remains applicable in these circumstances, including the existing lunar orbit of the Satellite and the limited provision of TT&C support and data-downlink within the United States, the Applicant provides the following information in response to various Part 25 legal requirements, including information requested in Section 25.114 of the rules and on FCC Form 312.

A. Legal Information

The Applicant submits the following legal information for the owner and operator of the Satellite, including the following information relating to Questions 1-8, 29-34 & 36-42 of the Form 312:

- **Name, Address and Telephone Number.** The Satellite is owned and controlled by the Indian Space Research Organisation, which is an agency of the government of India. The address and telephone number of a contact person for the Owner are:

Umang M. Parikh
Dy. General Manager & Associate Project Director
ISRO Telemetry, Tracking and Command Network
India Space Research Organisation
Telephone: (080) 2809 4508 /4522
Mobile: (+91) 9449516619

²⁷ See *DISCO II Order*, 12 FCC Rcd at 24169-72 (¶¶ 175-182).

²⁸ See, e.g., Chandrayaan-2 Agreement at Article 5.

- **Regulatory Status.** Owner operates the Satellite on a non-common carrier basis. The Applicant has entered into a contract to provide TT&C and a data downlink from the Earth Station to the Satellite, to the extent consistent with Commission requirements.
- **Basic Qualifications.** The answer with respect to Owner to each of the basic qualifications Questions 36-39 on FCC Form 312 is “No.” In response to Question 40, as noted above, the Owner is an Indian governmental entity. The Owner is not subject to denial of Federal benefits for reasons described in Question 41 of FCC Form 312.
- **Coordinating Administration.** The Satellite is authorized by India, which is the ITU administration responsible for its operations once achieving its desired orbit. The ITU information relevant to Chandrayaan-2, based on information provided the Applicant, is API/A 12050, IFIC 2857, ID No. 117545302. As published at ITU, the Satellite's Name is LMI (Chandrayaan-2).
- **Public Interest Considerations.** Public interest considerations supporting grant of this application are noted throughout the application and are summarized in Sections I, II and V herein.
- **Milestones, Bond and Related Requirements.** The Satellite was launched in July 2019, and was first inserted into lunar orbit in August 2019.²⁹ Accordingly, the Applicant hereby requests that the Commission waive any milestone, bond or related requirement, as the launch of the Satellite occurred well prior to submission of this Application.

B. Technical Information

Section 25.137 of the Commission's rules requires earth station applicants proposing to operate with non-U.S. licensed space stations to provide technical information for the non-U.S. licensed satellite in accordance with Part 25 of the rules. These requirements may not be uniformly relevant to a lunar-orbiting satellite that already is circling the Moon. However, to the extent necessary for the limited services proposed to be provided by the Earth Station to a lunar orbiting satellite in the Application, submitted herewith is a Schedule S to FCC Form 312 with information relating to the Satellite as required by Section 25.114(c) of the Commission's Rules.³⁰ Responses to certain aspects of Section 25.114 also have been included in this narrative

²⁹ See, e.g., Anonna Dutt, "Chandrayaan 2 enters lunar orbit, 'biggest milestone' achieved," HINDUSTAN TIMES (as updated June 2020) (available at <https://www.hindustantimes.com/india-news/in-a-big-leap-chandrayaan-2-enters-lunar-orbit/story-r9DJg0GTLh7QNokHX4jB4O.html>) (most recently viewed on November 3, 2021).

³⁰ As noted, information provided in this Application, including on Schedule S, with respect to the Satellite's orbit addresses the Satellite's orbit of the Moon, not Earth.

exhibit. However, for more information, please review the FCC Form 312 and the Attachments provided with this submission, including Attachments 1, 2 and 3.

- **General Description of the Satellite.** The Satellite is a lunar exploration/observation satellite already orbiting the moon. The Satellite is designed to support applications such as lunar topography, mineralogy, surface chemistry, regolith characterization, mapping of minerals and water molecules in polar regions, and other scientific advances. Specifically, as set forth in the Chandrayaan-2 Orbiter Mission attachment provided by the Owner, the Satellite is projected to have the following parameters:

Orbit: 100 km x 100 km Polar Orbit

Orbit Period: 118 Minutes

Number of revolutions per day: ~12

Tilt/Sun-Aspect Angle: Varies as follows:

Dawn-Dusk: Angle between sun and orbital plane > 30 degrees

Noon-Midnight: Angle between sun and orbital plane is < 30 degrees

Altitude: 100 km (+/- 25 km)

Attitude: Varies as follows, in order to maximize power generation

Dawn-Dusk: AD1 Noon-Midnight: AD2 (see below diagram)³¹

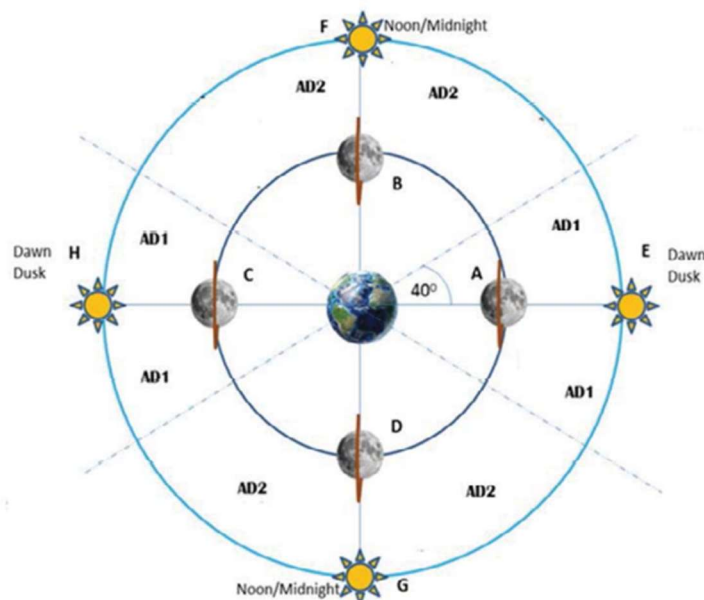


Figure 1.4: Orbiter Season Definition.

- **Satellite Orbital Information.** In addition to the information provided above and in Attachment 1 regarding the Satellite's 100 km x 100 km polar orbit, the

³¹ See, e.g., Chandrayaan-2 Handbook at 7.

accompanying Schedule S for the Satellite provides orbital information for this single Satellite with an orbital period of 118 minutes.

- **Information as to Radio Frequencies and Related Data.** The accompanying Schedules B (for the Earth Station) and Schedule S (for the Satellite) includes information, where applicable, concerning radio frequencies for the proposed uses of the Earth Station. With respect to the requested data downlink, the Satellite proposes to use its current downlinking frequency with the Earth Station, as follows:

Downlink Frequency: 8483.968 MHz
Polarization: LHCP
Modulation: QPSX
Data Rate: 4.2/8.4 Mbps (with coding)

Pursuant to the current Table of Frequency Allocations, 47 C.F.R. 2.106, Space Research services have a primary non-Federal allocation from 8450-8500 MHz.³² Per Section 2.1 of the Commission's Rules, "Space Research" includes a "radiocommunication service in which spacecraft or other objects in space are used for scientific or technological research purposes."³³ The ongoing mission of the Satellite, both as set forth in the Implementing Agreement with NASA and more generally, including as set forth herein and in Attachment 1, satisfy this definition. Accordingly, no waiver to use this frequency for data downlink should be required.

- **Description of Services to be Provided and Areas Served.** This narrative and the underlying FCC Form 312 provides a description of the transmission characteristics and performance objectives for the Satellite's service, including earth station parameters.
- **Antenna Gain Contours.** See Schedule S.
- **Power Flux Density Levels.** See Schedule S. Specifically, however, the power flux density levels are based on the following:

Chandrayaan 2	S-band	X-band
CH2O EIRP	-1	35
Path Loss (dBW)	211.6	223.1
Pd to PFD Conversion (dB)	10.98	10.98
Power Flux Density (dBW/m ²)	-223.58	-199.08

³² 47 C.F.R. § 2.106

³³ 47 C.F.R. § 2.1.

- **Tracking, Telemetry and Control Arrangements.** Within the United States, only the Earth Station is proposed to provide TT&C with respect to the Satellite, as set forth on Schedule B and S (and as set forth herein). Specifically:

TT&C Uplink (Earth to Space) Frequencies: 2041.598 MHz

- TC: 125 bps & CCSDS standard
- Modulation: PCM/PSK/PM
- Polarization: Circular (LCP & RCP)

TT&C Downlink (Space to Earth) Frequencies: 2217.120 MHz

- TM: 0.5/1/2/4 Kbps (with coding)
- Modulation: PCM/PSK/PM
- Polarization: Circular (LCP & RCP)

Outside of the United States, other TT&C support is provided by India's Deep Space Network ("IDSN").

- **Physical Characteristics of the Space Station.** In addition to the information provided on Schedule S, and the schematic provided in Section I of this exhibit, the Satellite has the following parameters:

Present Mass of Satellite (dry):	680 kg
Present Mass of Satellite:	888 kg
Launch Pad Mass of Satellite:	2379 kg
Nature of Solar Array:	Single
Orbiter Power:	1000 watts
Orbiter Dimensions (L x W x H):	5.84 m x 3.23 m x 2.16 m
Probability of Survival to End of Life:	50% (6 years from Jan. 2022)
Spacecraft Electrical Power at End of Life:	900 watts
Depth of Battery Discharge at End of Life:	75%

- **Orbital Debris Mitigation.** In its recent *Mitigation of Orbital Debris* order, the Commission concluded that "regulations specific to lunar and other orbits is premature" and it declined "to establish any such rules at this time, particularly as they relate to satellite disposal." ³⁴ The Commission noted added that it would require lunar and other non-Earth missions to provide information in applications "concerning limiting release of debris, limiting explosion risk, safe flight profiles, and plans for post-mission disposal, if any." ³⁵ Although it is not clear what information might be required for this sort of ongoing mission, that Owner has agreed with NASA to undertake certain measures with respect to orbital debris mitigation as part of the

³⁴ *Mitigation of Orbital Debris in the New Space Age*, Report and Order, IB Docket No. 18-313, 35 FCC Rcd 4156, 4223 (¶ 146) (2020).

³⁵ *Id.*

parties' Implementing Agreement should provide sufficient basis for the Commission to deem the Satellite in compliance with these requirements.

Specifically, in Article 9 of the Implementing Agreement, the Owner agreed that it "shall comply with the Space Debris Mitigation Guidelines of the United Nations Committee on the Peaceful Uses of Outer Space" and that "the Parties agree to plan for the mitigation of orbital debris originating from the launch, operation, and of life of mission, as part of the mission planning process."³⁶ In addition, with respect to the above, the Owner has coordinated with NASA's Jet Propulsion Laboratory ("JPL") with conjunction analysis for lunar orbiting spacecraft. To this end, the Owner provides trajectory information to JPL on a weekly basis. (JPL performs conjunction analysis for all spacecraft in lunar orbit.) Also, at the end of the current mission, which is expected to occur in approximately five to six more years, Owner may be able to raise the orbit to extend its useful life.

- **Coordination Considerations.** The Satellite has submitted its planned operations with the International Telecommunications Union ("ITU"): API/A 12050, IFIC 2857, ID No. 117545302. As detailed below, the Applicant also has undertaken frequency coordination through Comsearch for its proposed to be licensed operations.³⁷
- **Spectrum Availability, Interference Analysis & Default Service Rules.** As noted, and pursuant to the current Table of Frequency Allocations, 47 C.F.R. 2.106 (the "U.S. Table"), Space Research services, including the Satellite, have a primary non-Federal allocation from 8450-8500 MHz. In addition, the proposed operation has been coordinated through Comsearch. Accordingly, no waiver to use this frequency for data downlink should be required.³⁸

Similarly, Footnote 347 of the U.S. Table already specifies that non-Federal Earth-to-space transmissions in the 2025-2110 MHz band -- such as the proposed TT&C (Earth to Space) link using 2041.598 MHz here -- may be authorized "in the space research and Earth exploration-satellite services subject to such conditions as maybe applied on a case-by-case basis."³⁹ As the proposed Satellite should qualify as a space research service, the use of this band for the Satellite's TT&C use is consistent with

³⁶ Implementing Agreement at Article 9.

³⁷ See Attachment 2.

³⁸ To the extent a waiver of the specified default rules is necessary, permitting a deviation from the rules in the case of an already launched space-research satellite would better serve the public interest than would strict adherence to the general rule and is hereby requested.

³⁹ See 47 C.F.R. § 2.106, US Footnote 347 ("In the band 2025-2110 MHz, non-Federal Earth-to-space and space-to-space transmissions may be authorized in the space research and Earth exploration-satellite services subject to such conditions as may be applied on a case-by-case basis. Such transmissions shall not cause harmful interference to Federal and non-Federal stations operating in accordance with the Table of Frequency Allocations.")).

past Commission precedent.⁴⁰ Regardless, to the extent necessary, the proposed frequencies to be used for TT&C links should be granted or otherwise afforded waivers, as further set forth below, for the currently proposed uses -- at least pending Commission action on the pending allocation rulemaking in which the Commission proposed to allow the sort of uses and frequencies proposed in the Application.⁴¹

Spectrum Use Waiver. As noted, section 1.3 of the Commission's Rules authorizes the Commission to waive its rules for "good cause shown."⁴² That good cause exists to grant the Applicant (and, by extension, the Satellite) a limited waiver of the United States Table of Frequency Allocations ("U.S. Table") as described in section 2.106 of the Commission's Rules for the 2200 – 2290 MHz (Space-to-Earth) frequency band.

In considering request for case-by-case spectrum uses, the Commission has indicated that it would generally grant such waivers "where there is little potential for interference into any service authorized under the Table of Frequency Allocations, and when the case-by-case operator accepts any interference from authorized services."⁴³ Each criterion is met in this case, and the overall public interest benefits of the proposed service confirm the appropriateness of any required waiver.

First, the proposed operations are in support of a lunar space research satellite that will facilitate NASA's own effort to return a crewed mission to the Moon. The public interest benefits of the proposed services, as set forth in this Application, establish a clear presumption in favor of the requested waiver.

Second, the proposed TT&C (Space to Earth) frequency (2217.120 MHz) is within a frequency band that has been requested by other parties for TT&C uses⁴⁴ and appears to track future use of the bands by the Commission. Indeed, through an April 2021 order, the FCC added a limited TT&C allocation for secondary non-Federal space operation use, with proper coordination and without a waiver, in the 2200-2290 MHz band (albeit on somewhat different

⁴⁰ See 47 C.F.R. § 25.202(g) (permitting, subject to conditions, in-band use for TT&C within assigned bands). Consistent with the above, the Commission has approved TT&C use within sub-bands in this band (e.g., 2085 MHz) for other space research or EESS operations. See, e.g., *DigitalGlobe, Inc.*, Order and Authorization, FCC File No. SAT-MOD-20040728-00151 (rel. Sept. 30, 2005); *EarthWatch Incorporated*, Order and Authorization, 12 FCC Rcd 19556, 19558 (¶ 6) (IB 1997).

⁴¹ See *Allocation of Spectrum for Non-Federal Space Launch Operations, et al.*, Report and Order and Further Notice of Proposed Rulemaking, 36 FCC Rcd 7764, 7784 (2021) ("*Non-Federal Space Operations Order and FNPRM*"). Cf. 47 C.F.R. § 25.210(f) (noting that this requirement "does not apply to telemetry, tracking, and command operation").

⁴² See *Northeast Cellular Tel. Co. v FCC*, 897 F.2d 1166 (D.C. Cir. 1990).

⁴³ See, e.g., FCC File No. SES-STA-20040315-00475 (granting Applicant TT&C approval in these bands).

⁴⁴ See, e.g., Intelsat License LLC, Petition for Declaratory Ruling to Add HISPASAT 143W-1 to the Permitted Space Station List for Ku- and S-band Operations at 143 W.L. (submitted December 5, 2019) (requesting contingent TT&C operations in the 2072 and 2251 MHz frequencies).

terms than proposed here).⁴⁵ In addition, through a further notice of proposed rulemaking related to that same order, the Commission suggested additional allocations for non-Federal space operation uses, subject to coordination and certain other considerations, for 2025-2110 MHz (Earth to space) and for 2200-2290 MHz (space to Earth).⁴⁶ Notably, the Commission expressly proposed or suggested potential uses of these bands that appear consistent with those proposed in this Application. Specifically, for the 2200-2290 MHz band, the Further Notice of Proposed Rule Making asked whether "a greater range of non-Federal space operations should be permitted under the Space Operation allocation in this band," which may include uses beyond launch, including orbital and suborbital communications.⁴⁷ Moreover, as the Application proposes to support a government satellite that has an Implementing Agreement with NASA, the proposed TT&C frequencies should even be more readily accepted by the FCC, as they would be consistent with accepted Federal uses of the relevant bands.⁴⁸

Third, and crucially from a practical perspective, the proposed frequencies are consistent with the Satellite's other TT&C operations around the globe. Accordingly, grant of the proposed frequencies for the Satellite would significantly facilitate its ongoing and safe lunar operations by enabling it to use the same TT&C frequencies as its other TT&C operations.

Fourth, the proposed Earth Station TT&C operations are expected to be limited to approximately two or three passes per day, with each pass expected to last approximately 30 to 60 minutes. In addition, the relevant Earth Station operations are in the Hawaiian Islands -- which are among the most isolated inhabited islands on Earth. Accordingly, the proposed uses should pose limited burden on the relevant spectrum.

Fifth, as with prior Earth Station operations, the Applicant will coordinate with other parties operating communication systems in compliance with the U.S. to safeguard against harmful interference, and will conduct its TT&C operations only on a non-interference, non-protected basis. To this end, the Application has undergone frequency coordination via Comsearch.⁴⁹

Accordingly, the FCC, as necessary, should waive any limitation on the frequencies proposed to be used by the Earth Station in support of the Satellite, especially as the Satellite is already in lunar orbit.

⁴⁵ 47 C.F.R. § 2.106, US Footnote 96 (allocating frequencies including 2212.5 to 2217.5 MHz for non-Federal secondary use for space operations from launch vehicles and pre-launch testing) ; *see Non-Federal Space Operations Order and FNPRM*, 36 FCC Rcd at 7774 (¶ 22).

⁴⁶ *See, e.g., Non-Federal Space Operations Order and FNPRM*, 36 FCC Rcd at 7784 (¶ 47) & 7786 (¶ 51).

⁴⁷ *Id.* at 7786 (¶ 51).

⁴⁸ *See* 47 C.F.R. § 2.106 (listing space operations (space to Earth) and space research (space to Earth) as primary Federal uses of the 2200 to 2290 MHz band).

⁴⁹ *See* Attachment 2.

IV. APPLICATION PROCESSING ISSUES

This Application seeks an earth station license for an earth station to support an existing lunar-orbiting satellite. Requirements for such earth station applications for Earth-orbiting satellites were established in the Commission's *DISCO II Order*, and the Commission's *Satellite Licensing Order* did not revise these pre-existing procedures.⁵⁰ However, it is not clear if the same concerns or limitations should be applied to earth station support of a lunar satellite.

Nonetheless, to the extent necessary to license an earth station seeking to provide TT&C and data downlink support for a non-U.S.-licensed satellite of the Moon, the Applicant similarly requests that the Commission process the instant application pursuant to the first-come, first served procedure adopted for NGSO-like satellite systems. Like more traditional EESS systems that can operate on the same frequencies, the space research pursued by this lunar (and already in orbit) Satellite seems better suited to the first-come, first-served procedure than a modified processing round. Accordingly, the Applicant respectfully requests that the Commission does not introduce any unnecessary delay for processing this Application for an earth station for this already-orbiting Satellite, and, as necessary, waive for good cause any application processing rules in this case to the extent relevant for the proposed TT&C and data downlink set forth herein.

V. PUBLIC INTEREST CONSIDERATIONS

Grant of this application to license a new Earth Station (and include the Satellite as a new point of communication) would serve the public interest, convenience and necessity in at least the following ways:

- i. the continued service of the Satellite will facilitate and support the Satellite's scientific mission, including the collection and the analysis of lunar data important to the United States' return to the Moon with a crewed mission, pursuant to the implementing agreement between NASA and the Satellite's Owner, while -- because the Satellite is already in lunar orbit - posing no significant risk to other Earth-orbiting space stations
- ii. the Applicant has had a long and fruitful relationship with NASA and U.S. government clients, and this proposal will help it expand its service offerings, capabilities, and expertise so as to better serve those U.S. government operations;
- iii. the proposed permanent authorization will encourage additional expansion of the Earth Station, which may ultimately contribute to increased or more stable employment in this high-tech field for U.S. residents, and otherwise diversify the customer base for this U.S.-based operation; and

⁵⁰ See *Amendment of the Commission's Licensing Rules and Policies*, First Report and Order, IB Docket No. 02-34, 18 FCC Red 10760, ¶ 329 (2003).

iv. the proposed Earth Station operations will facilitate command and control operations for the Satellite, which will contribute to a safer and more reliable space environment for all space stations by offering further TT&C capabilities and redundancy.

For these and other reasons set forth in this application, the Applicant urges the Commission to find that grant of this application for a single Earth Station license will serve the public interest. In addition, to the extent any waivers may be required of the Commission's Rules for this proposed Earth Station operation, it is hereby requested, per the foregoing.

LIST OF ATTACHMENTS

Attachment 1: Chandrayaan-2 Orbit - Details (as prepared and approved by Leo Jackson John, ISTRAC, and B.N. Ramakrishna, ISTRAC/ISRO, respectively).

Attachment 2: Comsearch, Frequency Coordination and Interference Analysis Report, Naalehu, HI Satellite Earth Station (May 19, 2021)

Attachment 3: Radiation Hazard Study (June 2021)