

**Before the
Federal Communications Commission
Washington, DC 20554**

In the Matter of)
)
R2 Space, Inc.) File No. SAT-LOA-2020 ____ - ____
)
Application for Authority to Launch) Call Sign: ____
and Operate a Non-Geostationary)
Satellite Orbit System in the Earth-)
Exploration Satellite Service)

APPLICATION OF R2 SPACE, INC.

R2 Space, Inc. (“R2 Space”) hereby requests authority to launch and operate up to 8 microsattellites in low-Earth, non-geostationary (“NGSO”) orbit for provision of Earth-Exploration Satellite Service using frequencies in the S-band and the X-band allocated for this purpose. This application is submitted under the Commission’s streamlined licensing procedures governing small satellites, which were adopted on August 2, 2019.¹ Although these rules are not yet formally in effect, as set forth more fully in Section V.B. below, R2 Space respectfully requests a waiver of Section 25.114 of the Commission’s Rules to allow this application be processed under these streamlined small satellite rules.

I. BACKGROUND AND DESCRIPTION OF SERVICES

R2 Space, Inc. is a private company headquartered in Ann Arbor, Michigan. R2 Space was founded in 2018 with the goal of providing cutting-edge, remote sensing solutions to address the nation’s most difficult problems. Since its inception, R2 Space has developed new approaches

¹ See *Streamlining Licensing Procedures for Small Satellites*, 34 FCC Rcd 13077 and Appendix A, Adopted Rule 47 C.F.R. 25.122 (2019) (“*SmallSat R&O*”).

to help solve the U.S. Government's ("USG") remote sensing needs through commercial-grade synthetic aperture radar ("SAR") satellite technology.

R2 Space's first satellite network deployment of this technology is the XR constellation, which will consist of up to eight satellites (XR-1 through XR-8) equipped with SAR sensors capable of providing high-resolution imagery to USG customers. R2 Space will own and operate each XR satellite and will commit the entirety of each satellite's capacity to provide advanced data acquisitions services to its USG customers.

R2 Space is in a position to move quickly to launch and deployment of the space stations in its planned network. Accordingly, R2 Space respectfully requests grant of this application by the end of October 2020, which would allow it to launch its initial XR-1 satellite December 16, 2020, a timeline that is consistent with its current launch projection.

II. DESCRIPTION OF SYSTEM FACILITIES AND OPERATIONS

A. Space Segment, including Orbital Information

The XR satellite bus dimensions are 0.66 x 0.51 x 0.40 meters with a total mass of ninety kilograms. The satellite payload is a synthetic aperture radar sensor and data collection system consisting of an active phased array with both transmit and receive modules, transmit and receive radios, and a data converter (A/D and D/A). The SAR antenna is a 3.25 x 0.4-meter modular phased array with a gain of approximately 40 dB and a beamwidth of one degree on the short side and 0.4 degrees on the long side.

The XR satellites are designed to operate in Low Earth Orbit at an altitude of 550 kilometers and at an inclination angle of 97.7 degrees. The spacecraft use frequency assignments in the S-band, 2025-2110 MHz (command uplink) and 2200-2290 MHz (telemetry downlink), and in the X-band, 8025-8400 MHz (downlink) and 9500-9800 MHz (downlink) for mission data. The mission

data downlink bands are to be utilized solely to transmit raw SAR data, the command uplink will send operational commands to the spacecraft and TT&C downlink will transmit telemetry data to tracking earth stations. The basic specifications for all communication link channels are summarized in the table below:

Channel Purpose	Center Frequency (MHz)	Bandwidth	Polarization	Tx Power (Watts)
Mission Data Downlink	8300	150 MHz	LHCP	2
Command Uplink	2086.8	128 kHz	RHCP	N/A
Telemetry Downlink	2263.5	1.5 MHz	Linear	0.8

Each XR satellite has an expected operational lifetime of 3 years, at which time it will de-orbit naturally. R2 Space has utilized NASA’s Debris Assessment Software version 3.0.1 (“DAS”) to determine that all XR satellites will be compliant with existing orbital debris mitigation requirements. All XR satellites will de-orbit naturally before the 6 year maximum for small satellites, with no objects surviving reentry. Due to the LEO architecture of the network, reserve on-board propulsion is not required for the XR satellite to de-orbit before the 6 year mark. Post-mission disposal is achieved through the natural effects of atmospheric drag. For the detailed analysis, methodology, and assumptions underpinning this assessment, see the Orbital Debris Mitigation Plan, attached hereto as Exhibit B.

B. Ground Segment

The Mission Operations Center (“MOC”) for the XR NGSO satellites will be located at R2 Space’s office in Arlington, VA. Through its MOC, R2 Space will monitor and control all aspects of satellite operations.

R2 Space intends to use USG owned and operated ground stations and will augment this capability with up to one dozen additional facilities provided under contract with Amazon Web

Services and Atlas Space Operations, Inc., as necessary and as provided for by USG customers. Commercial ground terminals will be used only as limited operations with USG support, authorized on a case-by-case basis, and will not be used in any manner inconsistent with U.S. national security. Further details are provided in Exhibit A, the Technical Annex.

The company will coordinate all of its non-USG ground stations with Federal Earth stations operating in the relevant bands prior to operating any such FCC-licensed stations. R2 Space requests authority for such communications subject to appropriate standard conditions requiring coordination with co-frequency Federal Earth station operators.²

C. Launch Schedule

The initial satellite in the R2 Space network (XR-1) is expected to be launched on December 16, 2020 as a solo payload. Additional launches of XR series satellites are expected to take place sequentially thereafter to complete the network of 8 satellites.

[Text Continues on Next Page]

² See, e.g., Stamp Grant, HawkEye 360, Inc., IBFS File No. SAT-LOA-20190102-00001, Call Sign S3042, at Conditions 7 & 10 (granted Dec. 10, 2019) (“Transmissions in the 2025-2110 MHz and 2200-2290 MHz bands may only be made to/from earth stations coordinated with federal agencies, including NASA, the National Oceanic and Atmospheric Administration (NOAA), and the United States Air Force”).

III. REQUIRED CERTIFICATIONS FOR STREAMLINED TREATMENT.

R2 Space certifies pursuant to Section 25.122 of the Commission’s rules (see Section V.B., below) that the following requirements for streamlined processing are met for all space stations in the planned network:

Streamlined Requirement	R2 Space Compliance
(1) Space stations will operate only in non-geostationary orbit	<i>See, supra</i> , at 1 and Section II, A at 3; Technical Annex, Sec. I at 1 and Sec. II.A. at 2.
(2) Total in-orbit lifetime space station lifetime will be six years or less	3 Years. <i>See</i> Section II, A at 3; Technical Annex, Sec. II.A. at 2.
(3) Space stations will be deployed at an orbital altitude of 600 km or below	550 km. <i>See</i> Section II, A at 2; Technical Annex, Sec. II.A. at 2.
(4) Each space station will be identifiable by a unique signal-based telemetry marker to distinguish it from other space stations or space objects	<i>See</i> Technical Annex, Sec. IV at 9.
(5) The space stations will release no operational debris	<i>See</i> Orbital Debris Mitigation Plan Assessment at 2 & Sec. III.A. at 6.
(6) The probability of accidental explosions has been assessed and limited	<i>See</i> Orbital Debris Mitigation Plan Assessment at 2 & Section III.B. at 6-7.
(7) The probability of a collision between each space station and any other large object (10 cm or larger) during the orbital lifetime of the space station is 0.001 or less as calculated using current NASA software	<i>See</i> Orbital Debris Mitigation Plan Assessment at 2 & Section III.D. at 8.
(8) The space stations will be disposed of post-mission through atmospheric re-entry. The probability of human casualty from portions of the spacecraft surviving re-entry and reaching the surface of the Earth is zero as calculated using current NASA software	<i>See</i> Orbital Debris Mitigation Plan Assessment at 2 & Section IV.B. at 9.
(9) Operation of the space stations will be compatible with existing operations in the authorized frequency bands. Operations will not materially constrain future space station entrants from using the authorized frequency bands	<i>See</i> Section IV at 6-8; Technical Annex, Sec. V at 11-16.
(10) The space stations can be commanded from the ground to immediately cease transmissions and the licensee will have the capability to eliminate harmful interference when required under the terms of the license or other applicable regulations	<i>See</i> Section IV at 6; Technical Annex, Sec. V at 11-12.
(11) Each space station is 10 cm or larger in its smallest dimension	Satellite dimensions are 66 x 51 x 40 cm. <i>See</i> Section II, A at 2; Technical Annex, Sec. II.A. at 1.
(12) Each space station will have a mass of 180 kg or less, including any propellant	90 kg. <i>See</i> Section II, A at 2; Technical Annex, Sec. II.A. at 1.

IV. SPECTRUM USE AND SHARING ANALYSIS

R2 Space is committed to ensuring the protection from harmful interference of all licensed co-frequency spectrum users. The XR satellites will operate in all frequency bands used in a manner that will avoid harmful interference. Successful spectrum sharing is ensured in three principal ways: constant communication and transparency, low transmission time, and a small area of effect. Perhaps the most important of these is R2 Space's commitment to communication and transparency. The R2 Space MOC in Arlington, Virginia will be reachable 24 hours/day and will have the capacity to re-task or shut down any satellite transmissions promptly upon request. During operations the MOC will share up-to-date orbital characteristics (including ephemeris data), transmitting windows, and any other information required to ensure R2 Space's successful sharing of spectrum with other RF services. As necessary, the MOC will also be capable of defining "dark zones" in which the satellites will not transmit. R2 Space will coordinate with Federal and non-Federal operators in each band to ensure compliance. Below, R2 Space summarizes briefly the specific spectrum sharing environment for each of the frequency bands in which it proposes to operate. A more detailed discussion of compliance with all requirements for the avoidance of harmful interference is contained in the Technical Annex, attached hereto at Exhibit A.

A. S-Band Operations

1. 2025-2110 MHz

R2 Space plans to utilize the 2025-2110 MHz band for command uplinks under the Earth Exploration-satellite (Earth-to-space) allocation. Non-Federal Earth-to-space transmissions may be authorized in the EEES services subject to such conditions as may be applied on a case-by-case basis. Uplink transmissions shall not cause harmful interference to Federal and non-Federal stations operating in accordance with the Table of Frequency Allocations.

2. 2200-2290 MHz

R2 Space plans to utilize the 2200-2290 MHz band for TT&C downlink under the Earth Exploration-satellite (Space-to-Earth) allocation. Non-Federal Earth-to-space transmissions may be authorized in the EEES 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. Across all potential orbits, the PFD on the ground during TT&C downlink operations will remain safely under the limit, ensuring that no harmful interference occurs.

B. X-Band Operations

1. 8225-8375 MHz

R2 Space plans to utilize the 8225-8375 MHz band for payload data downlink under the Earth Exploration-satellite (Space-to-Earth) allocation. Harmful interference is avoided through two critical operating characteristics. First, the satellites operate in a non-broadcast mode, only radiating when transmitting data to one of our planned earth stations. Second, the satellites operate well below the power flux density requirements established in Table 21-4 of the ITU Radio Regulations. As detailed in the Technical Annex, across all potential orbits, the PFD on the ground during payload data downlink operations remains safely under the limit, ensuring that no harmful interference occurs.

2. 9500-9800 MHz

R2 Space plans to utilize the 9500-9800 MHz band for SAR imaging under the Earth Exploration-satellite (active) allocation. A critical means of interference avoidance in this band is the short transmit duration during operations. A nominal SAR image collection lasts for three seconds, and the satellites will be limited to 80 images per day. This means that the maximum imaging time for the satellites will be 240 seconds per day, corresponding to 0.278% of the day.

Not only is the imaging time/day minuscule, but the area of effect is also small. This is because the 3dB beamwidth of the SAR antenna is very tight (0.4 x 1.0 deg). On the rare chance a transmission from a satellite does interact with a system sharing the spectrum, R2 Space is confident that it will not cause harmful interference.

V. REQUESTS FOR WAIVER

The Commission may waive any of its rules if “good cause” is demonstrated.³ In general, waiver is appropriate if (1) special circumstances warrant a deviation from the general rule; and (2) such deviation would better serve the public interest than would strict adherence to the rule.⁴ As a general rule, the Commission will grant a waiver of its rules in a particular case upon a showing that the relief requested will not undermine the policy objective of the rule in question and will otherwise serve the public interest.⁵ In determining whether waiver is appropriate, it is well-established that the Commission should “take into account considerations of hardship, equity, or more effective implementation of overall policy.”⁶ All of these factors apply in this instance and the necessary criteria for grant are all squarely met, establishing good cause for grant of the requested waivers of both the Commission’s spectrum allocation rules and the space station application rules contained in Section 25.114.

A. Spectrum Allocation Rules

R2 Space requests a waiver of the U.S. Table of Frequency Allocations to the extent necessary to permit it to use spectrum in the 2200-2290 MHz band (space-to-Earth) for a TT&C

³ See 47 C.F.R. § 1.3; *Northeast 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).

⁴ See *Northeast Cellular*, 897 F.2d at 1166.

⁵ See *WAIT Radio*, 418 F.2d at 1157.

⁶ *WAIT Radio*, 418 F.2d at 1159.

downlink channel.⁷ This band is allocated to Space Operations (space-to-Earth) and EESS (space-to-Earth) on a co-primary basis across all ITU regions. In the U.S., however, this band is allocated exclusively for Federal government use.⁸

As detailed above, R2 Space's operations are designed to provide critical remote sensing and monitoring applications for support of the Federal government's critical national security missions. R2 Space's services will be used almost exclusively by the U.S. military and other federal government departments and agencies. The company will therefore work closely with relevant federal authorities to maximize cooperation and consistency with the U.S. government's priorities and objectives, and it will coordinate all frequency use with all affected Federal operators prior to transmission.

Accordingly, the requested waiver will affirmatively promote the public interest by facilitating efficient Federal use of spectrum and will not undermine in any way the purpose of the limitation on the U.S. allocation to Federal operations. Indeed, the proposed use is fundamentally consistent with the allocation as R2 Space, although a commercial operator requiring authority from the FCC, nonetheless will be providing its services in the band to Federal government users.

B. Space Station Application Processing Rules

This application describes a network of small space stations with characteristics that are fully consistent with streamlined licensing procedures governing small satellites that the Commission adopted nearly nine months ago, on August 2, 2019.⁹ Unfortunately, these rules have not yet been made effective, although the new regulations have completed, as of February 28,

⁷ See 47 C.F.R. §§ 2.102(a) & 2.106.

⁸ See 47 C.F.R. § 2.106, Footnotes 5.392 & US303.

⁹ See *SmallSat R&O*, 34 FCC Rcd 13077.

2020, the Office of Management & Budget review process under the Paperwork Reduction Act¹⁰ as well as the notice period under the Congressional Review Act.¹¹ The only remaining steps required to implement these new rules are certain ministerial actions to establish internal processing mechanisms for such applications and establish the effective date of the rules. Specifically, the Commission itself must publish a Public Notice establishing the effective date.¹²

Under these circumstances, it is very likely that the streamlined rules will become effective during the time this application is pending, so that it ultimately should be processed under these new rules. The Commission has often given the benefit of newly adopted rules to applications filed prior to the effective date of the new rules based either on the post-application effectiveness of an updated rule or simply on the fact that a not-yet-effective rule expresses current Commission policy¹³ These precedents are applicable here. Accordingly, R2 Space respectfully requests a waiver of Section 25.114 and associated provisions of the Commission’s Rules that would otherwise apply¹⁴ to the extent required to allow the Commission to accept this application for processing under the new rules adopted in 2019, including specifically the application requirements provision to be codified at Section 25.122 of the FCC’s Rules.

¹⁰ See *SmallSat R&O*, 34 FCC Rcd at 13127 (¶ 125); 44 U.S.C. §3507 and Office of Information and Regulatory Affairs, OMB Website at https://www.reginfo.gov/public/do/PRAViewICR?ref_nbr=201912-3060-009.

¹¹ See *SmallSat R&O*, 34 FCC Rcd at 13127 (¶ 125); 5 U.S.C. §801(a)(1)(A), 47 U.S.C. §159A(b)(2) and GAO Website at <https://www.gao.gov/fedrules/196425>.

¹² *SmallSat R&O*, 34 FCC Rcd at 13127 (¶ 125); see also 47 C.F.R. §1.427(a) (rules only become effective “after the Commission publishes a notice in the Federal Register announcing such approval and the relevant effective date,” no less than 30 days following publication).

¹³ See, e.g., *Telesat Canada*, 33 FCC Rcd 11469, 11477-78 (¶¶ 16, 18 & 20)(2018) and *Space Exploration Holdings, LLC*, 33 FCC Rcd 3391, 3394 & 3400-3402 (¶¶ 6, 21, 24 & 27)(2018) (both dismissing as moot several frequency use waiver requests in light of the post-application effectiveness of revised spectrum use rules); *Iridium Constellation LLC*, 31 FCC Rcd 8675, 8679-80 & 8686-87 (¶¶ 12 & 36) (IB/OET 2016) (waiving an existing rule prior to the effective date of a revision to the rule permitting mid-band TT&C operations based on the revised rule’s expression of current Commission policy).

¹⁴ See, e.g., 47 C.F.R. §§ 25.156, 25.157 and 25.217(b).

VI. GRANT OF THE APPLICATION IS IN THE PUBLIC INTEREST

Grant of this application will promote the public interest by facilitating the near-term deployment of newly developed SAR technology for the provision of low-cost, high-value strategic imaging services. The proposed XR constellation will take advantage of recent advances in small satellite technology as well as the Commission's new streamlined small satellite rules to bring new competition in the marketplace for Intelligence, Surveillance, and Reconnaissance solutions.

There is already significant U.S. Government demand for the imaging capabilities that R2 Space will offer, particularly within the U.S. military services and other agencies with a national security mission.¹⁵ USG customers will be able to leverage R2 Space's significant commercial investments in this innovative satellite technology while maintaining the highest security protocols. Prior to launch, R2 will complete a certification and verification process to ensure compliance with national security requirements and will support all customer encryption requirements for downlink communications.

Favorable action by October 2020 will allow R2 Space to provide competitive SAR services to USG agencies that are both cutting-edge and cost-effective by December 2020. This service will provide substantial benefit to the varied types of government users identified here. Accordingly, expeditious grant is in the public interest.

¹⁵ See, e.g., Defense Innovation Unit Website, About Page ("DIU is the only DoD organization focused exclusively on fielding and scaling commercial technology across the U.S. military at commercial speeds. We are focused on five technology areas where the commercial sector is operating at the leading edge: AI, autonomy, cyber, human systems, and space."), available at <https://www.diu.mil/about> (accessed April 23, 2020).

VII. OTHER MATTERS

A. Related FCC Authorizations

R2 Space was issued an experimental radio authorization under Call Sign WJ2XZJ on March 1, 2019 (*see* OET ELS File No. 0008-EX-CN-2019), and has been engaged in a testing program of SAR technology using aircraft mounted sensors flying at altitudes of up to 10,000 feet at several locations in the contiguous United States.

B. NOAA Authorization

R2 Space was issued a license to operate a private remote sensing space system by the National Environmental Satellite, Data, and Information Service of the National Oceanic and Atmospheric Administration (“NOAA”) on December 20, 2019. The NOAA license permits R2 Space to operate the private constellation of up to eight SAR satellites (the XR series satellites), subject to the conditions and terms of the license. The NOAA license includes findings that R2 Space satisfies the requirements for compliance and monitoring, will comply with the national security concerns of the United States, and will comply with all applicable international obligations and foreign policies.

C. ITU Compliance

Pursuant to 47 C.F.R. §§ 25.111 for space systems, it is understood that the commission will submit filings to the ITU on behalf of R2 Space pursuant to international obligations for the coordination and registration of space network systems. R2 Space will provide the commission the appropriate electronic files for submission to the ITU and hereby provides its commitment to the cost recovery of any such filings to the ITU.

VIII. CONCLUSION

For all of the foregoing reasons, R2 Space respectfully requests that the Commission place this application on Public Notice expeditiously in order to allow processing and final action in advance of the planned initial XR-1 satellite launch in December of 2020.

Respectfully submitted,

David S. Keir
Lerman Senter PLLC
2001 L Street, N.W., Suite 400
Washington, DC 20036
(202) 429-8970

Counsel to R2 Space, Inc.

May 10, 2020

By: *Reuben Sorensen*
Dr. Reuben Sorensen
Co-Founder and Chief Executive Officer
R2 Space, Inc.
535 W. William Street, Suite 400 South
Ann Arbor, MI 48103
Phone: (757) 288-3910