EXHIBIT A

R2 SPACE, INC. TECHNICAL ANNEX

TABLE OF CONTENTS

TECHNICAL ANNEX

I. Introduction and Background

R2 Space, Inc. is a private company headquartered in Ann Arbor, Michigan, with offices in Arlington, Virginia, and Huntsville, Alabama.[1] R2 Space was founded in 2018 with the goal of providing cutting-edge remote sensing solutions to the United States Government ("USG"), to help solve some of the nation's most difficult national security problems. To achieve this goal, R2 Space is requesting authorization to operate a private, non-geostationary ("NGSO") space system comprising up to eight small satellites, XR-1 through XR-8.

R2 Space will own and operate each XR satellite exclusively for its USG customers. Each XR satellite is designed to operate in Low Earth Orbits ("LEO") and will be equipped with Synthetic Aperture Radar ("SAR") sensors capable of providing high-resolution imagery to support the intelligence, surveillance, and reconnaissance needs of its USG customers.

II. System Facilities and Operations

A. Space Segment Including Orbital Parameters

The bus dimensions of each XR satellite are 0.66 x 0.51 x 0.40 meters with a total mass of 90 (ninety) kilograms. Each XR satellite is expected to be technically identical. In orbit, the phased array is deployed from the bus with dimensions of 3.25 x 0.4 meters.

The Attitude Determination and Control System ("ADCS") for each XR satellite consists of a GPS, Inertial Management Units, magnetometers, star trackers, torque rods, and reaction wheels and is capable of achieving a pointing accuracy of less than +/- 0.1 degrees and a GPS accuracy of less than five meters. Each XR satellite will carry propulsion for the purpose of orbit maintenance and intra-constellation phasing.

---

[1] Officers, directors, and stock ownership for R2 Space, Inc. are set forth in the Corporate Disclosures, attached hereto as Exhibit D.

The XR satellites are designed to operate in Low Earth Orbits. The XR-1 satellite will be the first deployment of the XR constellation with an anticipated launch date of December 16, 2020. Additional XR satellites will be launched subsequently thereafter. R2 Space plans to launch the XR satellites to an elevation of 550 kilometers at a 97.7-degree inclination angle, and the anticipated orbital parameters and expected range for the XR-1 satellite are set forth in the table below. R2 Space will provide exact operational inclination angle and elevation values prior to launch of each satellite.

XR-1 Orbital Parameters	Values	Accuracy
Inclination Angle (degree)	97.7	+/- 15
Apogee (km)	550	+/- 50
Perigee (km)	550	+/- 50
Semi-major Axis (km)	50	+/- 100
LTDN	9:30 AM	+/- 60 minutes

Each XR satellite has an operational on-orbit lifetime of less than 3 years, and will de-orbit naturally before the 6-year maximum in-orbit period. At the end of each satellite's operational life, the R2 Space Mission Operations Center ("MOC") will command the satellite to discontinue all station-keeping and begin a decaying orbit. R2 Space used NASA's Debris Assessment Software version 3.0.1 ("DAS") to calculate the total orbital lifetime of the XR satellites. The DAS outputs show that each XR satellite will naturally decay 2.683 years after the discontinuation of station-keeping, resulting in a total orbital lifetime of 5.683 years. The DAS outputs confirm that the XR satellites will comply with the relevant regulations. The XR satellites will de-orbit naturally within six years of deployment with no objects surviving reentry. Due to the LEO network architecture, propulsion is not required to de-orbit before the 6 year mark; post-mission disposal is solely dependent on atmospheric drag.[2] For a detailed description of the orbital debris analysis, methodology, and assumptions, see the Orbital Debris Mitigation Plan, attached to this application as Exhibit B.

B. Ground Segment

R2 Space will monitor and control all aspects of satellite operations through its MOC in Arlington, Virginia. 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 separately authorized on a case-by-case basis and used only with USG support as limited operations and will not be used in any manner inconsistent with U.S. national security.

Ground Station Owner	Ground Station Location
AWS Ground Station	New Albany, Ohio
AWS Ground Station	Boardman, Oregon
Atlas Ground Station	Mojave, California
Atlas Ground Station	Brewster, Washington
Atlas Ground Station	Harmon, Guam
Atlas Ground Station	Dundee, Scotland
Atlas Ground Station	Mingenew, Australia
Atlas Ground Station	Arwaua, New Zealand
USG Ground Stations	Determined by USG

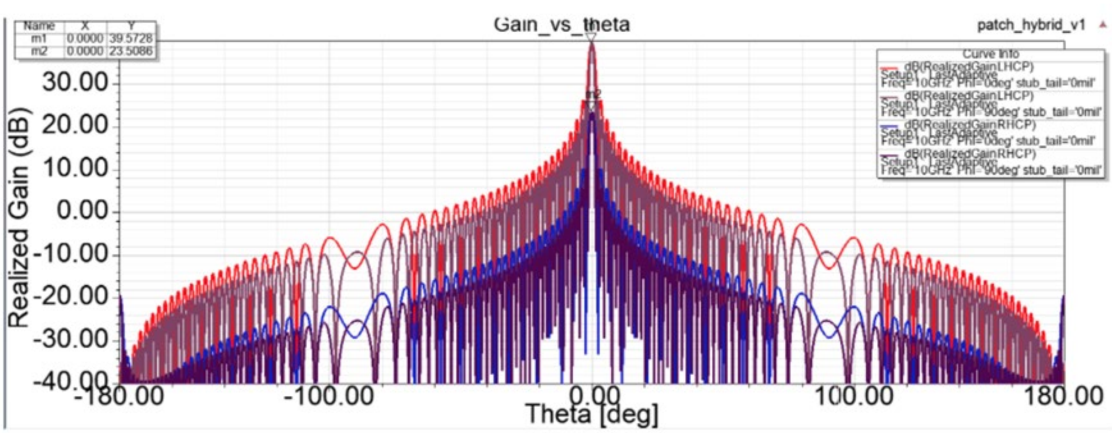
[2] As noted in the Orbital Debris Mitigation Plan, the XR satellites include propulsion systems and would be capable of carrying out a manual de-orbit maneuver if necessary. *See* Exhibit B, Orbital Debris Mitigation Plan.

Each XR space station can be commanded from the ground to immediately cease transmissions, and R2 Space will have the ability to eliminate harmful interference when required pursuant to the terms of the license or applicable regulations. R2 Space 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.

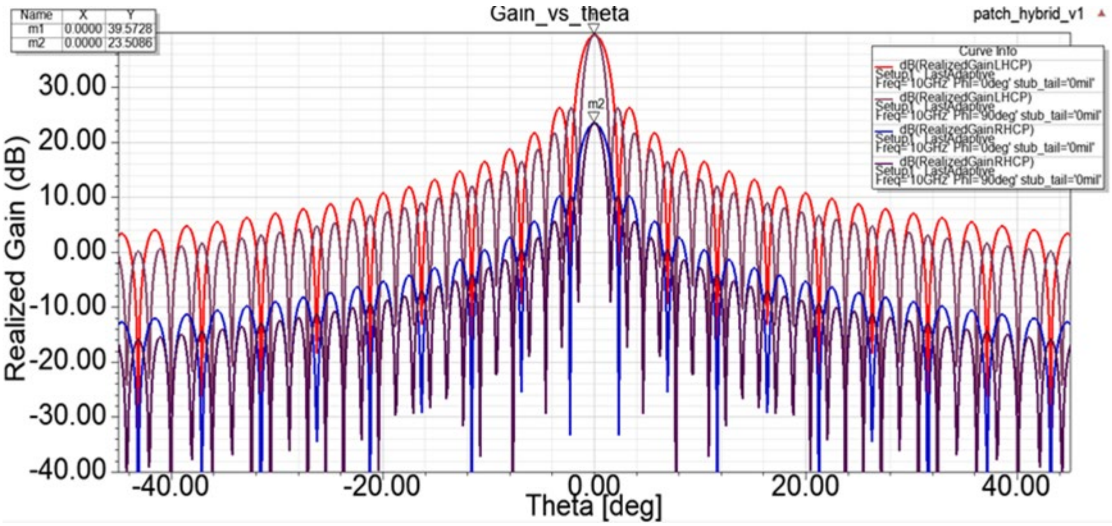
III. Description of SAR System

The sensor is a Synthetic Aperture Radar ("SAR") system consisting of an active phased array with transmit (Tx) and receive (Rx) modules, transmit and receive radios, and data converter (A/D and D/A). Receive modules are broken into two modes to enable duel receive technique for collection. Transmit and receive are partitioned for thermal management cycling. GaN-based power amplifiers with switching sequence using phase shifters for beam formation with azimuth and range control. 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 1 degree on the short side, and 0.4 degrees on the long side.

The SAR transmit beam pattern (long side) is shown in the figure below.



The SAR transmit beam pattern (short side) is shown in the figure below.



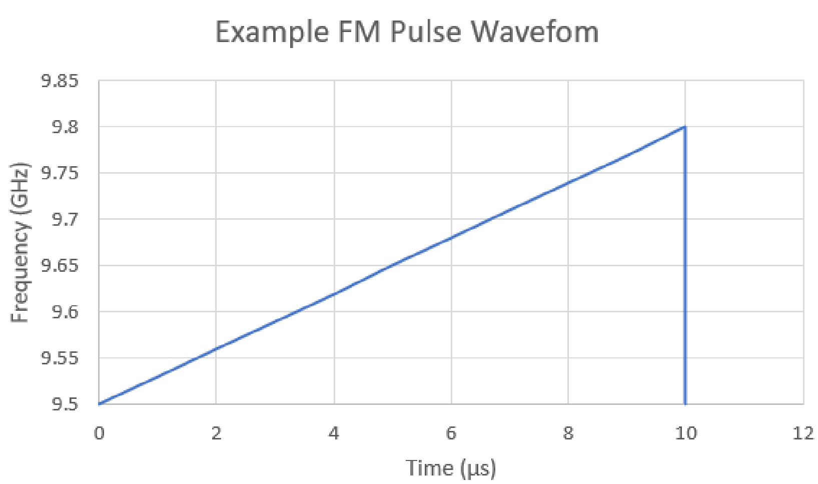
A. SAR Transmission Specifications

The XR satellite's SAR transmission event consists of a series of linear FM pulses transmitted at an even interval (pulse width) over a period of time (dwell time). The table below provides a full list of the SAR transmission characteristics for the XR satellites.

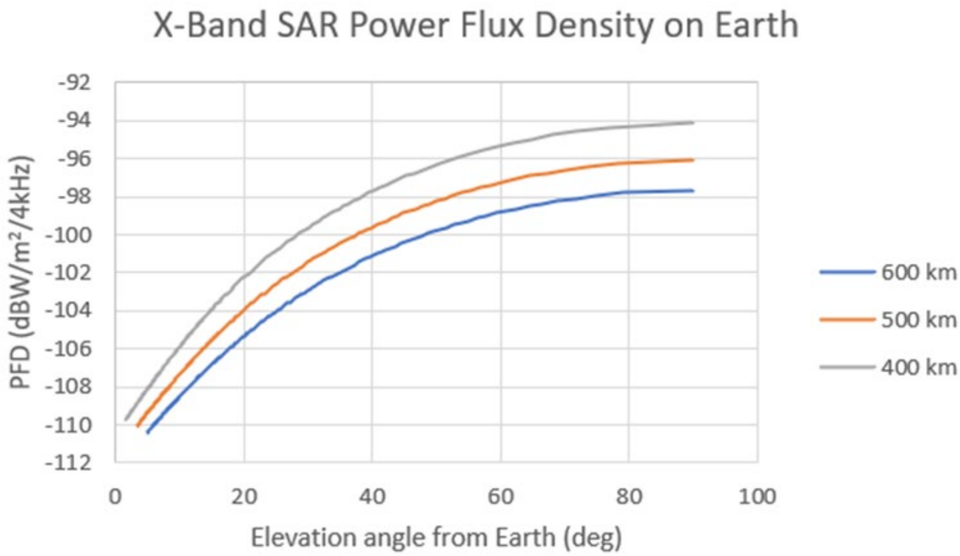
Specification	Value	Unit
Frequency Range	9.5-9.8	GHz
Center Frequency	9.65	GHz
Bandwidth	300	MHz
Frequency Tolerance	+/- 0.002	%
Noise Equivalent Sigma Zero (NESZ)	< -16.5	dB
Polarization	VV and HH	
-3 dB beamwidth (short side)	1	degrees

-3 dB beamwidth (long side)	0.4	degrees
RF emitted power (peak)	4	kW
RF emitted power (avg)	1	kW
Waveform	FM linear chirp	
Dwell Time	1-10	s
Pulse Width	30	µs

The figure below shows an example FM chirp waveform. During pulse transmission the frequency is linearly up-chirped across the 300 MHz of bandwidth over 30 µs.



The figure below shows the PFD on the Earth's surface in a 4 kHz band over varying incidence angles.



B. SAR Operating Modes

The XR satellites will have 4 distinct operating modes: (1) SPOTLIGHT, (2) SCANSAR, (3) STRIPMAP, and (4) STRIPMAP HIGH. Each XR series satellite will have the capability to transition between all operational modes in the same orbital pass. R2 Space has utilized the Xpatch software to analyze satellite performance in each of the collection modes. All resolutions, dimensions, and NESZs stated below are calculated in Xpatch using the lowest potential orbital altitude (300 kilometers). For SAR imaging, altitude does not affect resolution as resolution is only a function of bandwidth and pulse length. However, altitude will affect the swath widths and NESZ; the lower the altitude, the smaller the swath width and the higher the NESZ.

Mode	SPOTLIGHT
Resolution	1 meter
Number of Swaths	N/A
Image Dimensions	5 x 5 km frame

NESZ	< -19 dB

Mode	SCANSAR
Resolution	1 meter
Number of Swaths	3
Nominal Swath Width	120 km
NESZ	< -19 dB

Mode	STRIPMAP
Resolution	3 meters
Number of Swaths	3
Nominal Swath Width	30 km
NESZ	< -19 dB

Mode	STRIPMAP HIGH
Resolution	1.5 meters
Number of Swaths	1
Nominal Swath Width	25 km
NESZ	< -18.5 dB

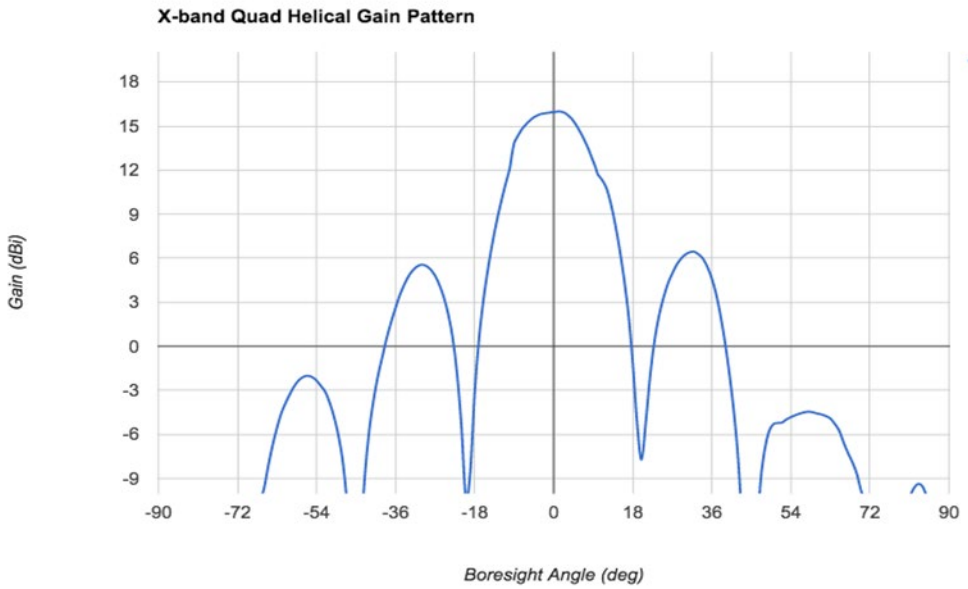
IV. Communication System Description and Antenna Beam Patterns

Each XR satellite will be equipped with 3 communication link channels: Payload Data Downlink, Command Uplink, and TT&C Downlink. Each communication link has its own specifications and uses. Payload Data Downlink is utilized solely to downlink raw SAR data, Command Uplink is for sending commands to the spacecraft, and TT&C Downlink is used to downlink telemetry and tracking data. Each XR satellite will be identifiable by a unique signal-based telemetry marker to distinguish it from other space stations or space objects.

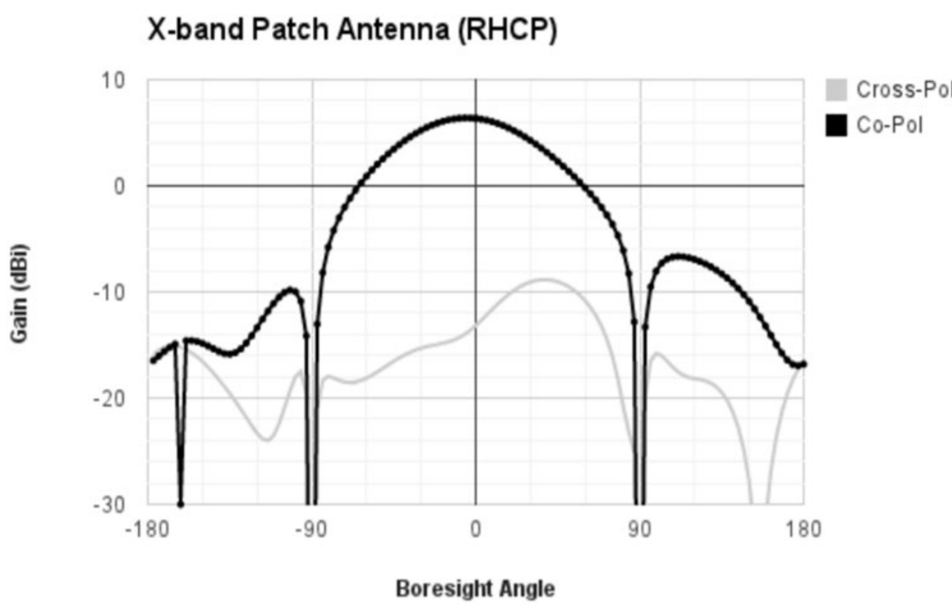
The communication specifications for each communication link channel are set forth in the table below.

Communication Link Channel	Payload Data Downlink	Command Uplink	TT&C Downlink
Center Frequency	8300 MHz	2086.8 MHz	2263.5 MHz
Bandwidth	150 MHz	128 kHz	1.5 MHz
Modulation	OQPSK	PCM/PM/SP-L	QPSK
Polarization	LCHP	RCHP	Linear
Tx Power	2 W	N/A	.8 W
EIRP	20.66 dBW	N/A	3.68 dBW

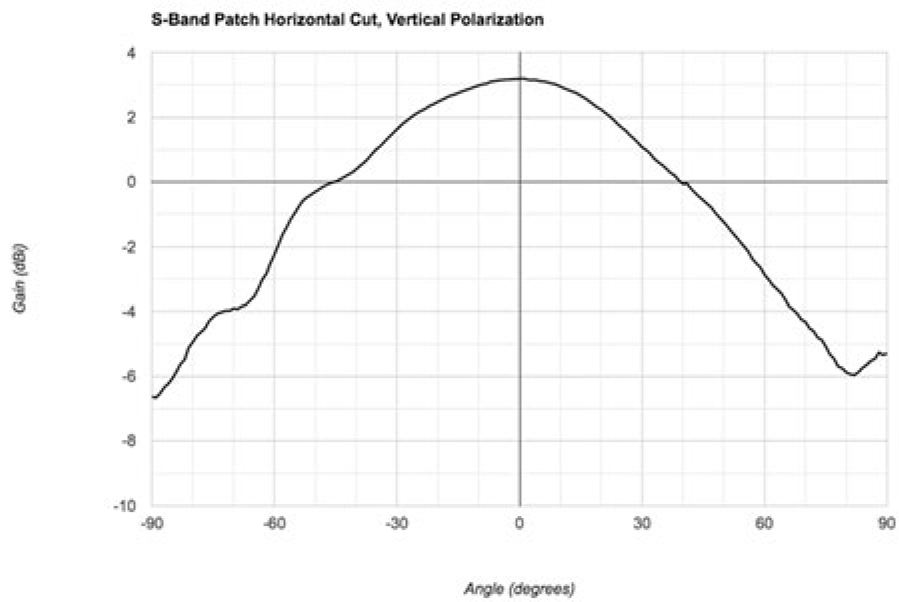
The communication antenna beam patterns for the XR satellites are displayed in the figures below, and are also set forth in Exhibit C. The figure below shows the X-band Quad Helical Gain Pattern.



The figure below shows the X-band Patch Antenna beampattern.



The figure below shows the S-Band Patch Antenna beampattern.



V. Interference 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 in a manner that is compatible with existing operations in the authorized bands, and that avoids harmful interferences. Operation of the XR satellites will not materially constrain future space station entrants from using the authorized frequency bands. Successful spectrum sharing is ensured in three main 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. R2 Space will monitor and control all aspects of satellite operations through its MOC in Arlington, Virginia. The MOC will be reachable 24 hours per day and will have the ability to re-task or shut down any satellite immediately upon request. During operations the MOC will share up-to-date orbital characteristics, 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 be capable of defining "dark zones" in which the satellites will not transmit. The space stations can be commanded from the ground to immediately cease transmission, and R2 Space will have the capability to eliminate harmful interference as required pursuant to the terms of the license or applicable regulations. Below, R2 Space addresses the specific spectrum sharing environment for each of the frequency bands in which it proposes to operate.

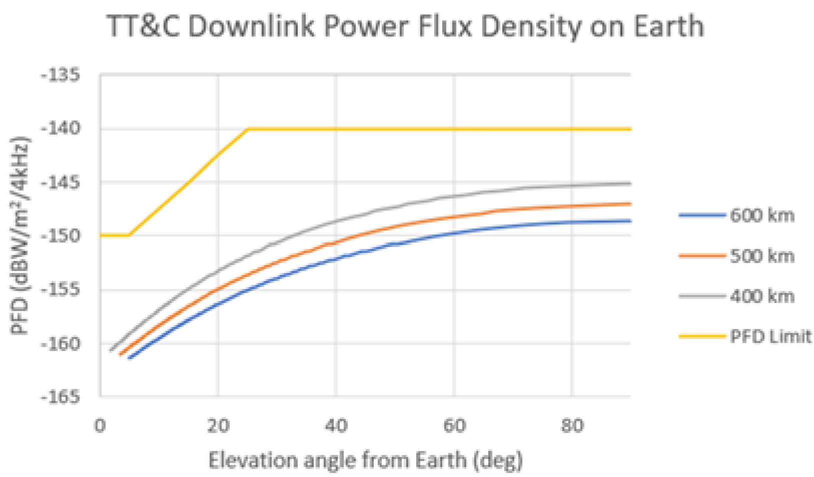
A. S-Band Operations

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. R2 Space will coordinate with Federal and non-Federal operators in this band to ensure compliance.

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. R2 Space will coordinate with Federal and non-Federal operators in this band to ensure compliance with this requirement. Below is a graph of the PFD on the ground at different elevation angles during a standard TT&C downlink event.



The PFD is calculated as follows: PFD [dB(W/m / 4 kHz] = EIRP (dBW) – 71 – 20log10(D) – 10log10(BW) – 24, where EIRP is the Maximum EIRP of the transmission, D is the distance between the satellite and affected surface area in kilometers, and BW is the bandwidth of the transmission in MHz.

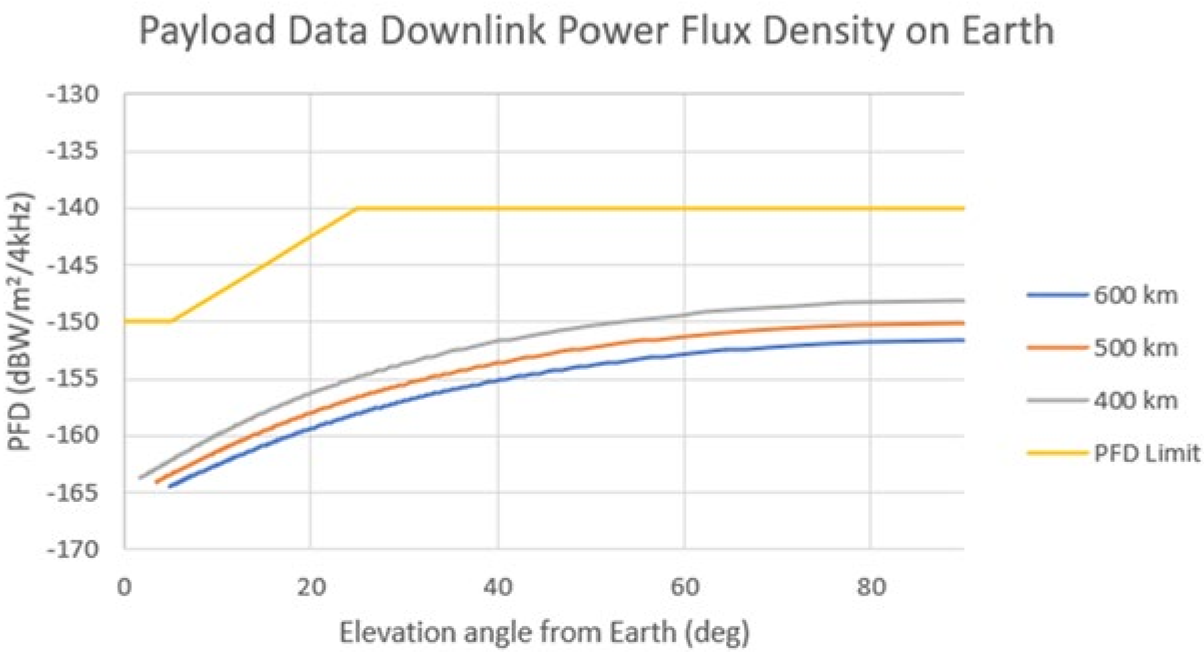
Across all potential orbits, the PFD on the ground during TT&C downlink operations remains safely under the limit, ensuring that no harmful interference occurs.

B. X-Band Operations

1. 8225-8375 MHz

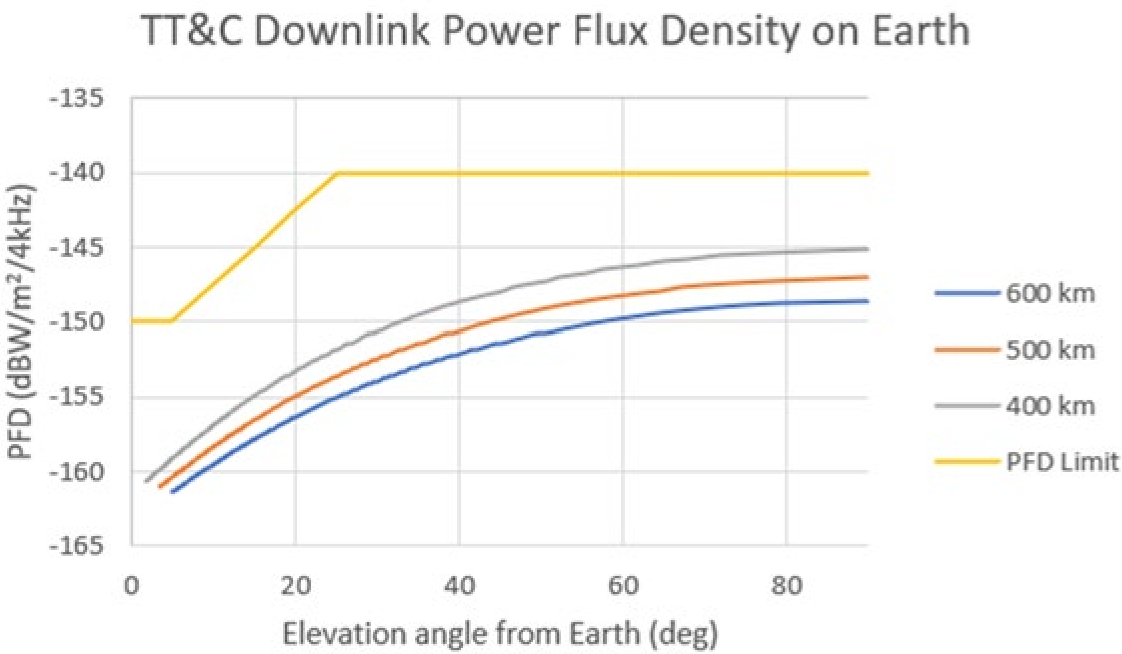
R2 Space plans to utilize the 8225-8375 MHz band for payload data downlink under the Earth Exploration-satellite (Space-to-Earth) allocation. Two key steps have been taken to minimize the risk of interference. First, XR satellites operate in a non-broadcast mode and only radiate when transmitting data to a planned Earth station. Second, XR satellites operate well below the Power Flux Density requirements.

ITU Radio Regulations (Table 21-4) states a Power Flux Density ("PFD") limit at the Earth's surface for space-to-Earth X-band EESS (8025–8400 MHz) emissions that must not exceed the following values: (1) -150 dB(W/m² /4kHz) for angles of arrival between 0 and 5 degrees above the horizontal plane; (2) -150 + 0.5(d – 5) dB(W/m² / 4kHz) between 5 and 25 degrees above the horizontal plane; and (3) -140 dB(W/m² / 4 kHz) angles of arrival between 25 and 90 degrees above the horizontal plane.



R2 Space has performed an analysis and proved that all communication links surpass this standard. As shown in the figure below, the XR satellite payload data downlink satisfies the PFD limits with at least 7 dB of margin at all angles of arrival.

The below figure shows that the TT&C Downlink channel also satisfies the PFD limits.

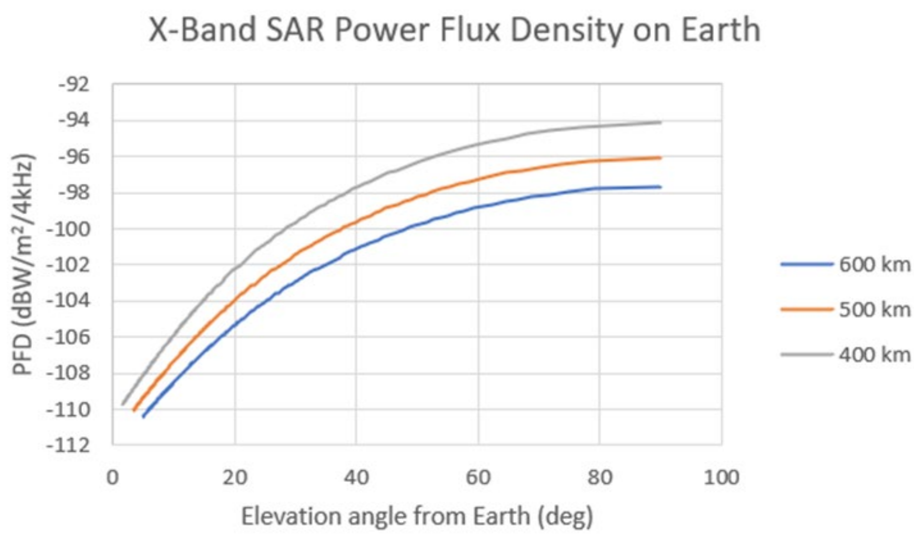


Across all potential orbits, the PFD on the ground during payload data downlink operations remains safely under the limit, ensuring that no harmful interference occurs.

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 XR satellites' short transmit duration during operations. A nominal SAR image collection lasts for three seconds, and each XR satellite will be limited to 80 images per day. This means that the maximum imaging time for the XR 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 XR SAR antenna is very tight (0.4 x 1.0 degrees). Depending on the type of image being collected, the imaging area ranges from 25 – 4,500 km^2. On the rare chance a transmission from an XR satellite does interact with a system sharing the spectrum, R2 Space is confident that it will not cause harmful interference.

Below is a graph of the PFD on the ground at varying elevation angles during a SAR image collection event.



VI. ITU Advance Publication and Cost Recovery

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 the applicant 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.

TECHNICAL CERTIFICATION OF DR. REUBEN SORENSEN

I, Reuben Sorensen, hereby certify, under penalty of perjury, that the following statements are true and correct to the best of my knowledge, information and belief:

1. I am the technically qualified person responsible for reviewing the engineering information contained in the foregoing Technical Annex, the related Schedule S and exhibits thereto;

2. I am familiar with Part 25 of the Rules of the Federal Communications Commission (47 C.F.R. § 25.101 *et seq.*); and

3. I have either prepared or reviewed the engineering information contained in the aforementioned documents and found it to be complete and accurate.

May 10, 2020

By: Reuben Sorensen

Dr. Reuben Sorensen
Co-Founder and Chief Executive Officer
R2 Space, Inc