Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Tyvak Nano-Satellite Systems Inc.	)	File No. 0987-EX-CN-2022
	)	
Application for Authority for Operation	)	
of Two Experimental Non-Geostationary	)	
Low Earth Orbit Satellites and	)	
Three Associated Earth Stations	)	

NARRATIVE EXHIBIT

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NARRATIVE EXHIBIT

Tyvak Nano-Satellite Systems Inc. ("Tyvak") provides nano-satellite, micro-satellite, and CubeSat space vehicle products and services that target advanced state-of-the-art capabilities for government and commercial customers to support operationally and scientifically relevant missions. With this Application, Tyvak requests three-year authority for its Pony Express 2 experimental mission, which involves the operation of two identical sun-synchronous non-geostationary ("SS-NGSO") low earth orbit ("LEO") CubeSat satellite referred to as Tyvak-0261 and Tyvak-0262.[1] The satellites will operate in orbit with an approximate three to five kilometer separation distance between them and will demonstrate RF communications crosslink and ranging technologies in a LEO environment. The Tyvak-0261 and Tyvak-0262 satellites are currently scheduled to be launched on February 1, 2023.

This application seeks experimental authority from the Commission to launch and operate the satellites and to permit their communications with three earth stations located within the United States. This application seeks Commission authority for the use of the RF communications links for the satellites and associated earth stations that are summarized below. Additional detail regarding these RF communications links is provided in Form 442 and in Section II of this Application.

Tyvak-0261 Satellite Transmission Links

- The Tyvak-0261 satellite will use the 400.84 MHz center frequency to transmit telemetry information to earth stations in the United States and other countries.

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[1] Tyvak currently holds experimental authorization from the Commission for similar CubeSats that are currently in operation. *See* ELS File No. 0987-EX-CN-2018 (Call Sign WK2XAJ) (granted April 27, 2020); 0527-EX-CN-2021 (Call Sign WJ2XZG) (granted Sept. 10, 2021): 0526-EX-CN2021 (Call Sign WJ2XZK) (granted Sept. 10, 2021).

- The Tyvak-0261 satellite will use a center frequency of 8380 MHz to transmit payload data to earth stations in the United States and other countries.

- The experimental payload on the Tyvak-0261 satellite will use the 2492 MHz band to transmit payload telemetry to earth stations in the United States operated by Lockheed Martin.

Tyvak-0262 Satellite Transmission Links

- The Tyvak-0262 satellite will use the 401.34 MHz center frequency to transmit telemetry information to earth stations in the United States and other countries.

- The Tyvak-0262 satellite will use a center frequency of 8320 MHz to transmit payload data to earth stations in the United States and other countries.

- The experimental payload on the Tyvak-0261 satellite will use the 2492 MHz band to transmit payload telemetry to earth stations in the United States operated by Lockheed Martin.

Inter-Satellite Links

- Both satellites will use a center frequency of 5800.41 MHz for Inter-Satellite Links used for ranging and timing between the satellites.

- Both satellites will use center frequencies of 22.60223 GHz and 24.5376 GHz for additional Inter-Satellite links used for data transmissions between the two satellites.

San Diego and Fairbanks Earth Station Transmission Links

- Tyvak earth stations in San Diego and Fairbanks will use the 401.08 MHz center frequency to transmit telecommand information to the Tyvak-0261 satellite.

- Tyvak earth stations in San Diego and Fairbanks will use the 401.58 MHz center frequency to transmit telecommand information to the Tyvak-0262 satellite.

Petaluma Earth Station Transmit Links

- A Tyvak earth station in Petaluma will use the 2050 MHz center frequency to transmit payload tasking instructions to both satellites.

In addition to the earth stations identified above, other earth stations located outside the United States will also be used to monitor and task the satellites, although FCC authority is not being sought for the operation of those earth stations. In addition, Lockheed Martin intends to use earth stations located in Waterton, Colorado and Camp Grayling, Michigan to communicate with

and transmit payload tasking instructions to the two satellites using the 904.4 MHz, 1397.5 MHz, 2250 MHz, and 2492 MHz center frequencies. This authority will be requested by Lockheed Martin through an application to modify experimental call sign WJ2XYS and not through this application.

I. NARRATIVE INFORMATION REQUIRED BY FCC FORM 442

Question 6A. Description of the Nature of the Research Project Being Conducted

The Pony Express 2 mission is a technology demonstration involving two 12U CubeSats using Lockheed Martin RF technology for signal characterization in a LEO orbit. The Tyvak-0261 and Tyvak-0262 satellites will operate in identical orbits with an approximate three to five kilometer separation distance and will carry RF payloads developed by Lockheed Martin for receiving, crosslink, and ranging communication to facilitate demonstration capabilities.

Question 6B. Showing that the Communications Facilities Requested are Necessary for the Research Project

The successful completion of the above-described technology demonstration requires the use of the communications facilities identified in this application. The use of RF communications equipment both on the satellites and at the earth stations are necessary to monitor and control the satellites, direct their operations, and to downlink the resulting experimental information for collection and analysis. Of particular importance is the use of off-the-shelf radio equipment that is designed to be compatible with the uniform payload form factor requirements of CubeSat spacecraft and has been demonstrated to be available and reliable for use in space-based communications.

Question 6C. Showing that Existing Communications Facilities are Inadequate

Currently, there are no identified comparable communications facilities to support the operation of the CubeSat system for any of the required operations. RF equipment capable of operating in higher frequency bands may be unable to satisfy the form factor requirements or the low power usage requirements of a CubeSat spacecraft.

Question 10. Transmitting Equipment to be Installed, Including Manufacturer, Model Number and Whether the Equipment is Experimental in Nature

Satellite Transmitting Equipment

The transmitting components aboard the Tyvak-0261 and Tyvak-0262 satellites are controlled by a dedicated on-board processor, which processes data for transmission, sends and receives data from the modem, and activates the appropriate radio systems depending on the state of operations. Each vehicle possesses a UHF system for vehicle command and telemetry retrieval and an X-Band system for data download and an S-band system for payload command.

The TT&C communications system uses a Tyvak-developed UHF radio derived from commercially available UHF communications systems. The radio operates at a 19.6 kbps rate using GMSK modulation. The UHF system has an RF output power of 1 watt and uses a custom designed half-wave dipole antenna. The identical radio was previously used on the Tyvak-0129 satellite and has operated without problem.

The payload S-band communications system operates at 2 watts using an off-the-shelf Quasonix NanoTX radio and Printech Circuit Labs path antenna for transmission, and the Innoflight SCR-106 for receiving data. Similar to the UHF radio, the S-band radio has previously been used on-orbit several times without any problems.

S-band transmissions are completed with managed downlinks and the vehicle does not transmit in the S-band unless commanded by the ground to enable based on the ground station's GPS location or via absolute time. The S-band radio supports a 2 Mbps BPSK data rate using a transmit power of 2 watts. The antenna is RHCP with a gain greater than 5 dBic at the boresight with a VSWR < 2:1. The S-band radio is also capable of operating in GMSK modulation.

The X-band downlink communications systems operates at 2.5 watts using an off-the-shelf Innoflight SCR-106 radio for transmission of data. X-band transmissions are completed with managed downlinks and the vehicle does not transmit X-band unless commanded by the ground to enable based on the ground station's GPS location or via absolute time. The X-band radio is set to permit a 40 Mbps BPSK, QPSK, OQPSK, and 8PSK data rate using a transmit power of 2.5 watts. The antenna is RHCP with a gain not greater than 17.8 dBic at the boresight with a VSWR < 2:1.

Earth Station Equipment

The UHF band earth station facilities each consists of a Yagi antenna array manufactured by M2 Systems, model number 400CP30. The UHF Ground Station locations in the United States are located in San Diego, California and Fairbanks, Alaska.

The S-band and X-band ground earth station in the U.S. is located in Petaluma, California and consists of a 3.7-meter antenna manufactured by Seatel as model number 3700. The antenna is located on the roof of an access-controlled building in Petaluma, California. Tyvak will control the earth station remotely from its Mission Operations Center ("MOC") in Irvine, California.

Lockheed Martin will operate additional earth stations operating in the UHF and S-band located in Waterton, Colorado and Camp Grayling, Minnesota. These earth stations will communicate with the satellite payload and will not control the operation of the satellites.

Authority for the operation of these earth stations with the Tyvak satellites is being requested separately by Lockheed Martin through an application to modify experimental call sign WJ2XYS.

Question 11A. Is the Equipment Listed in Item 10 Capable of Station ID Pursuant to Section 5.115

As required by Section 5.115 of the Commission's rules, both the Tyvak-0261 and Tyvak-0262 satellites and their associated earth stations in the United States are designed to include station identification information within every transmission.

Question 4: Antenna Registration Form; Operation of Directional Antenna

Tyvak-0261 and Tyvak-0262 are LEO satellites in a 550 km Sun-Synchronous Non-geostationary Orbit ("SS-NGSO") with an inclination of 97.7 degrees and an orbit period of approximately 96 minutes. The satellite will pass over the Earth stations roughly one to fifteen times per day depending on its location with an average access time of five to eleven minutes for each earth station location. The UHF earth station will use a computer-controlled tracking antenna to point the earth station's antenna in the direction of the moving satellites. The antenna has a maximum gain of +20.2 dBi along the bore-sight of the antenna and a half-power beam-width (i.e., -3 dB) of approximately 22 degrees. The antenna array uses four off-the-shelf, Yagi-type antennae developed by M2 Antenna Systems, Inc.

Since the satellites operate in an SS-NGSO orbit, the range of antenna azimuth and elevation will vary based on the relative motion of the satellite with respect to the ground station. It will also differ for each satellite pass. The earth station will only transmit above the horizon. Consequently, the range of antenna elevation angles for all satellite passes will be between 0 and 180 degrees. The azimuth can vary between 0 degrees and 360 degrees.

II. RELEVANT INFORMATION ADDRESSED IN SECTION 25.114 OF THE COMMISSION'S RULES

ITU Cost Recovery

See attached ITU Cost Recovery Letter.

Radio Frequency Plan

UHF Communications System

The UHF communications system for the Tyvak-0261 satellite operates using a center frequency of 400.84 MHz (space-to-earth) for telemetry communications and 401.08 MHz (earth-to-space) for telecommand. The UHF communications system for the Tyvak-0262 satellite operates using a center frequency of 401.34 MHz (space-to-earth) for telemetry communications and 401.58 MHz (earth-to-space) for telecommand.

The downlink communications link of the Tyvak-0261 satellite at 400.84 MHz is within the 400.15-401 MHz frequency band, which is allocated internationally and in the United States in the space-to-Earth direction for both Federal and non-Federal Space Research and on a secondary basis to Space Operations. The Tyvak-0261 is using this frequency for vehicle telemetry downlink and thus the use/categorization of the telemetry (*i.e.*, space-to-earth) communications as Space Research and/or Space Operation is justified in both the US and internationally.

The downlink communications link of the Tyvak-0262 satellite at 401.34 MHz is within the 401-402 MHz frequency band, which is allocated internationally and in the United States for both Federal and non-Federal Meteorological Aids, Space Operation (space-to-Earth), Earth Exploration-Satellite (Earth-to-Space), Meteorological-Satellite (Earth-to-space). The Tyvak-0262 satellite is using this frequency for vehicle telemetry downlink and thus the use/categorization

of the telemetry (*i.e.*, space-to-earth) communications as Space Operation is justified in both the US and internationally.

The uplink communications link for the Tyvak-0261 satellite at 401.08 MHz and for the Tyvak-0262 satellite at 401.58 are both within the 401-402 MHz frequency band. As noted above, the 401-402 MHz frequency band is available for both federal and non-federal use for Earth Exploration-Satellite Service (Earth-to-Space). Although the satellites will not conduct Earth imaging operations, their research activities into satellite ranging and ISL communications will help to support future Earth imaging operations and should therefore be permitted on an experimental basis as an activity that is consistent with the Earth Exploration-Satellite Service allocation that exists both the U.S. and internationally.

The communications parameters for the UHF communications system for the space-to-earth and earth-to-space links are shown in the following table.

Satellite UHF Communications Parameters	**Value**
Emission Designator	28K8G1D
Service	Digital Data
Center Frequency	400.84 MHz (Tyvak-0261) 401.34 MHz (Tyvak-0262)
Requested Bandwidth (includes Doppler)	28.8 kHz
Modulation	GMSK
Data Rate	19,600 bps
Polarization	Linear (Results in RHCP)
Antenna Type	Dipole
Antenna Gain	0 dBi (Max)
RF Power Output	1W
Line/Misc Losses	-2dB
ERP	0.385 W

Table 1: Satellite UHF Communications Space-to-Ground Parameters

Earth Station UHF Communications Parameters	Value
Emission Designator	28K8G1D
Service	Digital Data
Center Frequency	401.08 MHz (Tyvak-0261) 401.58 MHz (Tyvak-0262)
Requested Bandwidth (includes Doppler)	28.8 kHz
Modulation	GMSK
Data Rate	19,600 bps
Polarization	Linear (H, V) or Circular
Antenna Type	Yagi array
Antenna Gain	+22.3 dBi (Max)
RF Power Output	100 W
Line Losses	-3dB
ERP	5190 W

Table 2: Tyvak Earth Station UHF Communications Parameters

Earth Station	Frequency Range	Geographic Coordinates
San Diego, CA, USA	UHF	32.897°Lat, -117.201°Long
Fairbanks, AK, USA	UHF	64.85°Lat, -147.68°Long

Table 3: Tyvak U.S. Earth Stations UHF

S-Band Communications System

2050 MHz. The S-band uplink communications system operates using a center frequency of 2050 MHz and an earth station on the rooftop of an access-controlled building located in Petaluma, California. Tyvak will control the earth station from its MOC in Irvine, California. The communications parameters for the S-band communications system for the earth-to-space links are shown in the following tables.

Earth Station Communications Parameters	Value
Emission Designator	250KG1D
Service	Digital Data
Center Frequency	2050 MHz
Requested Bandwidth (includes Doppler)	250 kHz
Modulation	BPSK
Data Rate	125 kbps
Polarization	RHCP
Antenna Type	S-band dish
Antenna Gain	+34.9 dBic (Max)
RF Power Output	3.5 W
Line Losses	-3 dB
ERP	3305 W

Table 4: Tyvak Earth Station S-Band Communications Parameters

Earth Station	Frequency Range	Geographic Coordinates
Petaluma, California	S-Band	38°16’29” N 122°39’48.5”W

Table 5: Tyvak U.S. Earth Stations S-Band

2492 MHz. The S-band communications system on the payload of each of the two satellites operates in the space-to-earth direction using the 2492 MHz band for transmission of payload telemetry data to earth stations operated by Lockheed Martin in the United States. The communications parameters for these transmissions are provided in the table below.

Payload Transmitter	
Waveform	DVB-S2 formatting per the ETSI EN 302 307, 2M0F3D, BPSK or QPSK Modulations
Frequency	2492 MHz
Bandwidth	250 KHz – 2 MHz
Tx Power	27 dBm
Antenna Gain	Peak 2.8 dBi
EIRP	27 dBm
Polarization	LHCP

Table 6: Satellite S-band Space-to-Earth Transmissions

X-Band Communications System

The spacecrafts' X-band communications system will operate within the 8025-8400 MHz frequency band to downlink recorded payload data. All or portions of this spectrum is allocated for operations involving the Earth Exploration-Satellite (space-to-earth), the Fixed, the Fixed-Satellite (earth-to-space), and the Meteorological-Satellite (earth-to-space) services. Pursuant to footnote US258, however, this spectrum is available on a primary basis for non-federal Earth Exploration-Satellite (space-to-earth) operations.

Transmissions between the satellite and the ground will be with Tyvak's earth station in Petaluma, California. The communications parameters for the X-band communications system for the space-to-earth links are shown in the following tables.

CubeSat Communications Parameters	**Value**
Emission Designator	15M0G1D
Service	Digital Data
Center Frequency	8380 MHz (Tyvak-0261) 8320 MHz (Tyvak-0262)
Requested Bandwidth	15 MHz
Modulation	BPSK, QPSK, OQPSK, 8PSK
Data Rate	40 Mbps
Polarization	RHCP
Antenna Type	Patch
Antenna Gain	+17.7 dBic (Max)
RF Power Output	2.5W
Line Losses	-1dB
ERP	71.3 W

Table 7: Tyvak CubeSat X-Band Communications Parameters

Earth Station	**Frequency Range**	**Geographic Coordinates**
Petaluma, California	X Band	38°16'27.2" N 122°39'48.5"W

Table 8: Tyvak U.S. Earth Stations X-Band

The satellites will communicate with the X-band ground station only when they are within line-of-sight of the earth station and have received a communication from the earth station directing the spacecraft to initiate transmissions. Consequently, the spacecrafts will utilize the X-band only when in contact with the specified earth station.

Payload Communications System (Space-to-Space)

The spacecrafts' payload system will use space-to-space communications for a technology demonstration involving RF communications, ranging and timing. The payload will use transmissions with a center frequency of 5800.41 MHz for ranging and timing between the satellites. Although 5800.41 MHz is not allocated for space-to-space earth links, the selection of this band was made to support a U.S. government customer and can be used by the two satellites for very short range crosslinks without interfering with any other use of this spectrum. The details of the 5800.41 MHz ranging and timing signals are provided in the following table:

Payload Communications Parameters	**Value**
Emission Designator	05M0F3D
Service	Ranging and Timing
Center Frequency	5800.41 MHz
Requested Bandwidth	5 MHz
Modulation	BPSK @ 1.024 Mcps
Data Rate	1.024 Mcps
Antenna Gain	5 dBi
Transmit Power	17 dBm
EIRP (peak)	22 dBm

Table 9: Payload 5 GHz Ranging Link Parameters

The spacecrafts' payload system will operate space-to-space inter-satellite links using the paired frequencies of 22.60223 GHz and 24.5376 GHz, both of which are available for inter-satellite links pursuant to Section 25.202(a)(5) of the Commission's rules. The details of the inter-satellite links are provided in the following table:

Payload Communications Parameters	Value
Emission Designator	2M0F3D
Service	Inter-satellite Data Links
Center Frequencies	22.60223 GHz and 24.5376 GHz
Requested Bandwidth	2 MHz
Waveform	DVB-S2 formatting per the ETSI EN 302 307
Modulation	QPSK
Data Rate	1 Mbps
Antenna Gain	11.1 dBi
Transmit Power	28 dBm
EIRP (peak)	-2dBW

Table 10: Payload ISL Data Link Parameters

Other Payload Communications Links

As noted in the introduction to this narrative, the technology demonstration payload on the satellites will also receive signals from two earth stations operated by Lockheed Martin located in Waterton, Colorado and Camp Grayling, Minnesota. These earth stations will transmit tasking and test signals to the payloads using the center frequencies of 904.4 MHz, 1397.5 MHz, and 2492 MHz. This range of frequencies is being used to demonstrate the capabilities of the technology. Commission authority for these communications links will be requested by Lockheed Martin pursuant to a modification application of experimental license call sign WJ2XYS and therefore are not addressed further herein.

Orbital Location

Tyvak-0261 and Tyvak-0262 satellites operate in LEO with the orbit parameters shown in Table 11. The satellites will be in a natural motion circumnavigation (NMC) formation with a separation distance of approximately three to five kilometers. The accuracy of the orbital parameters will be within +/- 5 kilometers in altitude and +/- 0.05 degrees in inclination. The

satellites have an orbit period of approximately 96 minutes with typical ground access times of five to eleven minutes per pass. The orbit parameters are presented in the following table:

Spacecrafts	Parameter	Units	Value
Tyvak-0261 Tyvak-0262	Orbit Period	Hrs	1.57 hrs
	Orbit Altitude	Km	550 km (SSO)
	Inclination	Deg	97.7 degrees

Table 11: CubeSat Orbit Parameters

Physical Characteristics of the Satellites

The Pony Express 2 satellites are 12U CubeSats designed to demonstrate and improve the technology readiness level of various payloads and vehicle components. Two identical spacecraft will be in LEO to perform the demonstration for a minimum of 6 months but with a design lifetime of 3 years.

The satellites use subsystem modules built from printed circuit boards (PCB) or miniature enclosures secured to a primary structure consisting of panels and rails. The panel and railed open structure permit the vehicle to be built incrementally with access for integrating subsystem modules and securing interconnect harnessing. The subsystems are placed within the vehicles to optimize mass properties, radiation protection, thermal heat rejection, power handling, vehicle orientation, and cabling length. The deployable solar arrays attach to the primary structure and face towards the same direction. The vehicles are primarily constructed out of aluminum and PCB materials.

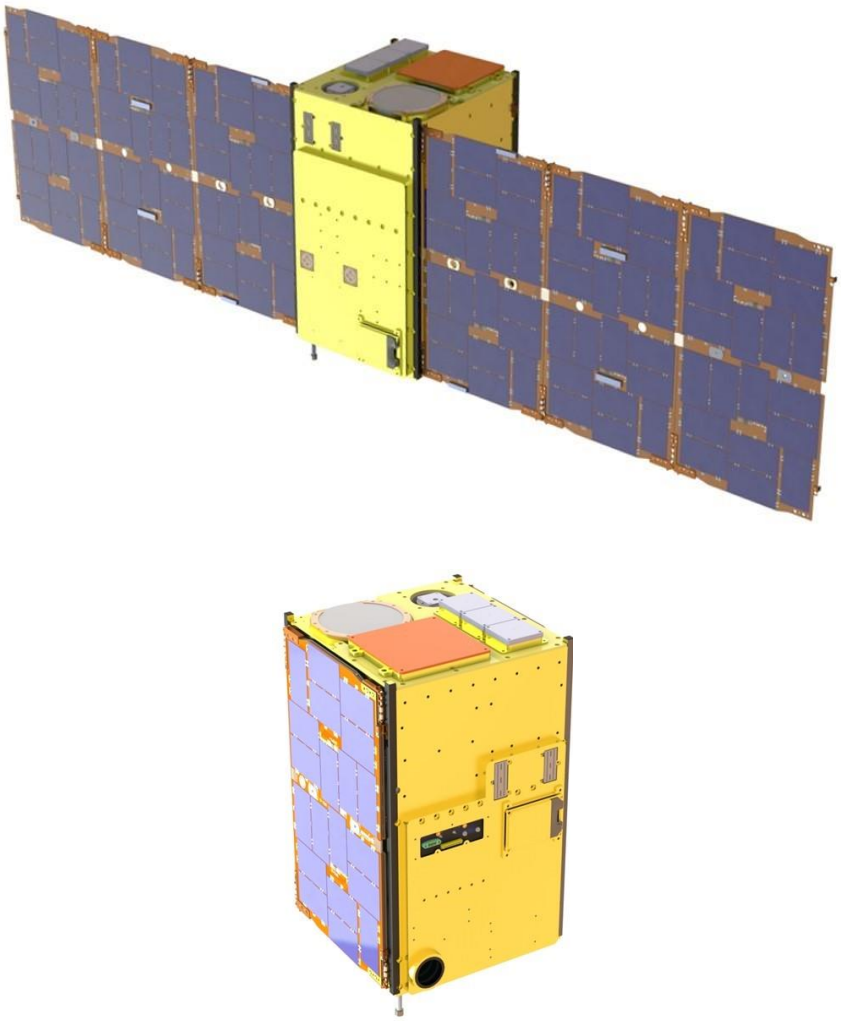

Figure 1: Spacecraft Vehicle Layout

Parameter	Value
Total spacecraft mass at launch, including all propellants and fluids	26.616 kg
Dry Mass of spacecraft at launch, excluding solid rocket motor propellants	26.116 kg
Identification, including mass and pressure, of all fluids	NONE
Fluids in Pressurized batteries	NONE. Battery uses unpressurized standard COTS Li-ion battery cells
Identification of any other sources of stored energy	NONE
Identification of any radioactive materials on board	NONE

Table 12: Summary of Spacecraft Parameters

Description of Propulsion Systems

The propulsion system consists of one gridded ion thruster. This ion thruster used iodine, stored as a solid in an unpressurized tank, to generate thrust using electricity on the order of 0.3 to 1.1 mN.

Description of attitude control system

The attitude determination and control system consist of the flight computer, inertial measurement unit, reaction wheels, GPS receiver, sun sensors, magnetometers, and torque rods.

Description of any range safety or other pyrotechnic devices

None.

Description of the electrical generation and storage system

Energy generation is accomplished using two deployable solar array wings. Energy storage is accomplished using standard COTS Li-ion battery cells. The cells are recharged by the solar cells mounted on the deployable solar arrays. The power management and distribution are provided by the electrical power system and battery protection circuitry.

Operational Schedule

The Tyvak-0261 and Tyvak-0262 satellites are currently scheduled to be launched on February 1, 2023. The project timeline and major milestones for the operation of the Tyvak-0261 and Tyvak-0262 satellites are provided in the following table.

Milestone	**Date**	**Notes**
Launch	February 1, 2023	ToL + 0
Decommissioning	February 2025	ToL + 2 years
Re-entry	February 2026	ToL + 3 years

Table 13: Tyvak Satellites Major Milestones

General Description of Overall System Facilities, Operations and Services

Please see the response to Question 6A of this Application.

Public Interest Considerations

This is a technology demonstration experimentation mission being undertaken in association with Lockheed Martin, which is seeking to demonstrate higher fidelity RF capabilities that could be used in future missions for a U.S. government customer. The proposed operation is expected to verify and advance the technical capabilities for ranging and communication between satellites in LEO and is therefore of potential benefit to both the U.S. space industry and the U.S. federal government.

Predicted Spacecraft Antenna Gain Contours

The spacecraft UHF antenna is a half wavelength L-dipole antenna, which is essentially omni-directional when mounted on the corner of a CubeSat structure. A simulation of the antenna design is shown in Figure 2.

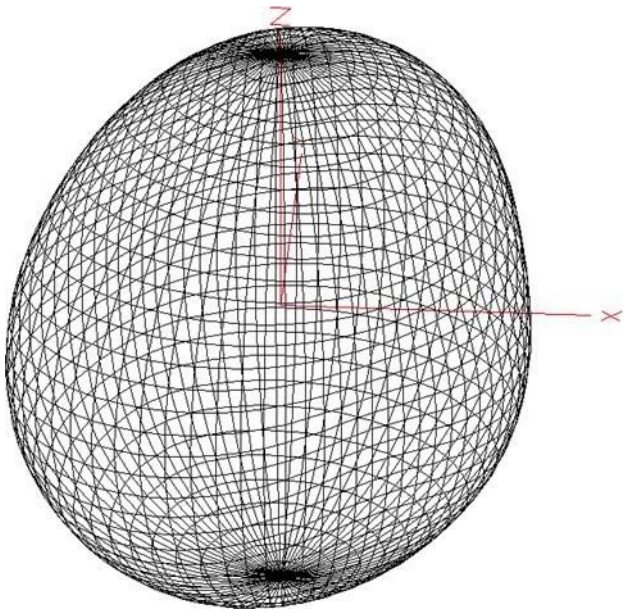

Figure 2: Satellites L-Dipole UHF Antenna Gain Plot (Notional)

Orbital Debris Mitigation

The CubeSats spacecraft mitigate orbital debris by the following means:

Section 25.114(d)(14)(i) Limiting the amount of debris released during normal operations and the probability of the satellite becoming a source of debris by collisions with small debris or meteoroids that could cause loss of control and prevent post-mission disposal

In order to limit the amount of debris generated during normal operations, the satellites have been designed so that all parts will remain attached to the satellite during launch, ejection and normal operations. This requirement is intrinsic to all satellites conforming to the CubeSat Standard. Catastrophic system failure due to orbital debris or micrometeoroid impact will not affect

the vehicle's ability to de-orbit within the guidelines for vehicles operating in LEO (*i.e.*, less than 25 years). As reflected in the accompanying ODAR report, based on a worst case orbital altitude of 565 kilometers (the planned mission orbit is 550 kilometers), the satellites are anticipated to re-enter the atmosphere within 10 years after their three-year operational mission based on lifetime prediction simulations for the current mission epoch (*i.e.*, launch in CY2023). The propulsion system for each satellite is therefore not planned for use to further expedite reentry.

Section 25.114(d)(14)(ii) Limiting the probability of accidental explosions during and after completion of the mission operations

The steps taken to limit the probability of accidental explosions during and after the operational mission are detailed in Section 4 of the accompanying ODAR report for the satellites. They include the following measures. The propulsion system for each satellite consists of one gridded ion thruster. This ion thruster used iodine, stored as a solid in an unpressurized tank to generate thrust without the risk of a pressurized explosion. In addition, the vehicles possess energy storage devices (*i.e.*, Li-ion batteries), which will be disconnected from the solar panels and charging circuitry and left in a nearly discharged state as part of the decommissioning procedure.

Section 25.114(d)(14)(iii) Limiting the probability of the satellite becoming a source of debris by collisions with large debris or other operational space stations

The probability of the satellites colliding with large debris or other space systems of sizes one centimeter or greater at the planned mission orbit altitude and inclination is negligible. Although the vehicles do possess propulsive capability for station keeping, no maneuvers to avoid in-orbit collisions are planned for or anticipated. The satellites will be in a natural motion circumnavigation (NMC) formation with a separation distance of approximately three to five kilometers. The accuracy of the orbital parameters will be within +/-5 kilometers in altitude and

+/- 0.05 degrees in inclination, thus avoiding any potential for a collision between the two spacecraft.

The launch provider has also instituted deployment procedures in order to place the co-manifested satellites into slightly different positions in order to reduce the risk of collision. One of these procedures is to stagger deployment times.

Section 25.114(d)(14)(iv) Post-mission disposal plans for the space station at end of life

The post-mission disposal plan for the satellites includes the transition of all vehicle systems to a dormant state, which includes the cessation of all radio operations (*i.e.*, transmit and receive). Energy storage devices will be held at a minimal charge state at the end of the life of the vehicles as discussed above in response to Section 25.114(d)(14)(ii) of the Commission rules. In addition, the spacecraft reaction wheels will be passivated at end-of-mission through a series of commands to reduce wheel momentum to a minimum level and then to transition the vehicle to free drift mode. The free drift mode does not utilize any attitude control actuators, specifically the reaction wheels. The power service to the reaction wheels will also be deactivated so that no inadvertent switch to another attitude control mode can actuate the reaction wheels.

Re-entry debris and probability of human casualty will be negligible. The materials used on the vehicle include aluminum and PCB material, which have a relatively low melting temperature as compared to other materials such as Ti or stainless steel, and are not expected to survive reentry. Only reinforced carbon material of the solar panel assembly is expected to survive reentry and produce debris. Total Debris Casualty Area for these parts are 2.55 m^2 and 0.87 m^2 with kinetic energy equal to 111.11 joules and 1.02 joules respectively. The predicted Total Debris Casualty Area of the Pony Express 2 satellites is 2.55m^2 and the risk of Human Casualty is 1:32,100

below the required 1:10,000 limit. The modeling inputs for these calculations are provided in Appendix B of the accompanying ODAR report.

III. SPECTRUM SHARING

The Tyvak-0261 and Tyvak-0262 satellites have been designed to include several precautions to prevent harmful interference to other services from its RF communications. These include the use of low-altitude orbits and the use of short-duration, narrow bandwidth transmissions. The spectrum sharing capabilities for the satellite UHF, S-band and X-band communications links are addressed in individual sections below. The inter-satellite links for the payload portion of the spacecraft will operate at very short range with relatively low power levels and therefore do not pose an appreciable risk of interference to other spectrum users either on the ground or in space.

UHF Spectrum Sharing

As noted above, the UHF communications link for the Tyvak-0261 satellite will operate in the space-to-earth direction using a center frequency of 400.84 MHz, which is within the allocations for Space Research (primary) and Space Operations (secondary) within the 400.15-401 MHz frequency band. The UHF communications system for the Tyvak-0262 satellite will operate in the space-to-earth direction using a center frequency of 401.34 MHz. This is within the 401-402 MHz frequency band, which is allocated internationally and in the United States for both Federal and non-Federal Meteorological Aids, Space Operation (space-to-Earth), Earth Exploration-Satellite (Earth-to-Space), Meteorological-Satellite (Earth-to-space). The two satellites will receive earth-to-space communications in the 401.08 MHz and 401.58 MHz bands, both of which are also within the larger 401-402 MHz frequency allocation. This spectrum sharing

analysis will therefore first address spectrum sharing in the 400.15-401 MHz band and then in the 401-402 MHz band.

400.15-401 MHz Band

As noted above, the 400.15-401 MHz frequency band is allocated internationally and in the United States on a primary basis to the Mobile Satellite Service ("MSS") (space-to-earth), the use of which is limited to non-geostationary satellite orbit spacecraft (ITU RR 5.209). In the United States, MSS is further limited to non-Federal satellite systems operating in the non-voice, non-geostationary ("NVNG") satellite service. (US319 and 320).

The band is also allocated both internationally and in the United States to Meteorological Aids, Meteorological Satellite, Space Research and on a secondary basis to Space Operations. All of these allocations are in a space-to-Earth direction, although the Space Research service is additionally allocated in the space-to-space direction. In the United States, all of these allocations are available for both Federal and non-Federal systems, except for Meteorological Satellite, which is allocated solely for Federal use.

Mobile Satellite Service

As noted above, the MSS allocation in the United States is limited to NVNG systems in the space-to-Earth direction.[2] Orbcomm Licensee Corporation ("Orbcomm") is an NVNG MSS operator that is a longstanding user of this spectrum. Orbcomm is licensed to operate eighteen NVNG satellites at a target altitude of 750 kilometers using the bands 400.15-400.505 and 400.645-

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[2] *See Amendment of Section 2.106 of the Commission's Rules to Allocate Spectrum to the Fixed-Satellite Service and the Mobile-Satellite Service for Low-Earth Orbit Satellites*, Report and Order, 8 FCC Rcd 1812 (1993); 47 C.F.R. §§ 2.106 n.US320.

401 MHz on a primary basis, and in the reminder of the band on a shared basis with any future NVNG MSS systems. Tyvak understands that Orbcomm uses the 400.15-401 MHz band solely for gateway downlinks.[3] Therefore, Tyvak will be able to avoid causing any harmful interference to Orbcomm's operations simply by refraining from having its satellite transmit within view of an Orbcomm gateway facility. Based on Tyvak's review of Orbcomm's earth station licensing records, Tyvak has not identified any Orbcomm gateway earth stations that appear to be within range of Tyvak's San Diego or Fairbanks earth stations. Therefore, Tyvak will be able to avoid causing harmful interference to Orbcomm's operations in the 400.15-401 MHz band.

Recently, the Commission authorized several other companies to operate NVNG satellite systems using the 400.15-401 MHz band, although two of these proposed operators, Hiber Inc. [4] and Swarm Technologies, Inc.[5] have already surrendered their authorizations.

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[3] *See* Modification Application of Orbcomm License Corporation, Narrative Description, File No. SAT-MOD-20070531-00076 (granted March 21, 2008).

[4] *See* Hiber, Petition for Declaratory Ruling, File No. SAT-PDR-20180910-00069 (Sept. 10, 2019). On May 6, 2020, Hiber Inc., was authorized by the Commission to operate a NVNG system consisting of 24 low earth orbit ("LEO") satellites using service links in the downlink direction in the 400.15-401 MHz band. Hiber's proposed constellation was authorized to operate at an altitude of approximately 600 kilometers, above Tyvak's anticipated altitude of 525 kilometers. Hiber surrendered its authorization on September 24, 2021 and concurrently reported that it was no longer planning to launch its network. *See* Letter from Bruce Henoch, General Counsel, Hiber Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission (Sept. 24, 2021).

[5] *See* Swarm Technologies, Inc., IBFS File No. SAT-PDR-20200228-00021. Swarm had proposed to operate a NVNG constellation consisting of 450 satellites operating at a variety of inclination angles and using altitude ranges from 325 to 585 kilometers. Swarm proposed to use the 400.15-401 MHz band for downlink communications.

The Commission also granted authority to Astro Digital U.S., Inc.'s to conduct TT&C operations in the space-to-Earth direction within the 400.15-401 MHz band.[6] Astro Digital intends to transmit only in the 400.48-400.52 MHz portion of the band, however, well below Tyvak's proposed operations at 400.8256-400.8544 MHz.

On May 29, 2020, Myriota Pty. Ltd. ("Myriota") was authorized by the Commission to operate a constellation consisting of 26 LEO satellites operating in a sun-synchronous (97.7°) or at a 54° inclination angle. Myriota has since sought to modify its authorization to increase its constellation size to 36 satellites[7] and, accordingly, has not yet begun to launch its commercial-grade satellites. The target altitude for Myriota's satellites is 600 kilometers or lower (but above 400 kilometers). The network, once launched, would use the 400.15-401 MHz band for downlink communications.

On November 18, 2021, Kineis was authorized by the Commission to operate a NVNG constellation consisting of 25 nanosatellites operating at an altitude of 650 kilometers in a sun synchronous (98° inclination angle) orbit that would use the 400.15-401 MHz band for downlink communications.[8] Kineis has not reported the launch of any satellites to the Commission.

Still other companies have applied for authority to operate NVNG systems using the 400.15-401 MHz band. Fleet Space Technologies Pty Ltd ("Fleet Space") has requested authority to operate a constellation of 40 satellites that would operate at an altitude of 582 kilometers with a

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[6] See Amendment Application of Astro Digital US, Inc. for Authority to Launch and Operate a Non-Geostationary Satellite Orbit System in the Earth-Exploration Satellite Service, Stamp Grant, File No. SAT-AMD-20200528-00064 (Granted In Part, Oct. 9, 2020).

[7] *See Myriota Pty Ltd,* IBFS File No. SAT-MOD-20211214-00191.

[8] *See Kinéis,* IBFS File No. SAT-PDR-20191011-00113.

53 degree orbital inclination.[9] Fleet Space would use the 400.05-401 MHz band for space-to-Earth communications with its user terminals.

Orbital Sidekick, Inc. has requested authority to operate a small fleet of six hyperspectral imaging satellites operating in the Earth Exploration Satellite Service using portions of the 400.15-401 MHz band for space-to-earth TT&C links.[10] Orbital Sidekick is proposing to operate a single 40 kHz link in this band using the secondary Space Operations allocation.[11] This satellite would be controlled using an earth station in Santa Clara, California, outside the range of Tyvak's earth stations in San Diego and Fairbanks.

Once these operators begin launching their satellites, Tyvak will likely need to coordinate with certain of them to ensure that Tyvak's brief space-to-earth transmissions in the 400.15-401 MHz band do not interfere with their satellite networks. Given Tyvak's need to transmit signals to and from its satellites only for relatively brief periods and only within view of its associated earth stations, Tyvak is confident that its proposed spectrum use can easily be coordinated with these satellite systems as they are launched.

Terrestrial Services

Appendix 5 of the ITU Radio Regulations requires satellite network operators using the 400.15-401 MHz band to coordinate with co-frequency terrestrial services if the PFD levels of the satellites 400.15-401 MHz frequency band exceed the coordination threshold, which is in excess of -125 dB(W/(m^2•4 kHz)).

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[9] *See Fleet Space Technologies Pty* Ltd, IBFS File No. SAT-LOO-20211214-00194.

[10] *See* IBFS File No. SAT-LOA-20220325-00035.

[11] *See Technical Annex to Supplement Schedule S* at Table A.2.b-2.

The Tyvak satellites operate in the range of 550 kilometers. The satellites operate with an EIRP of 0.631 W using a 28.8 kHz bandwidth. Using a worst case orbital altitude of 500 kilometers with transmission directly toward the Earth, this results in a PFD level of: -135.545 dB(W/(m^2) per 4 kHz band. This level does not exceed the threshold given in the ITU Radio Regulations and, therefore, no coordination of the UHF downlink will be necessary with the terrestrial stations of any Administration.

Federal Systems

Pursuant to 25.260 of the Commission's rules, space systems operating downlinks in the 400.15-401 MHz band must not transmit signals into the "protection areas" of satellites operated by the Department of Defense ("DoD"). The protection area for such a DoD satellite is the area on the Earth's surface in which the DoD satellite is in line of sight from the ground at an elevation angle of five degrees or more above the horizon and, to preserve this protection area, FCC-authorized satellite must not transmit in the 400.15-401 MHz band when at a line-of-sight elevation angle of zero degrees or more from any point on the ground within the protected area of a DoD satellite operating in that band. Tyvak will comply with these requirements by avoiding transmissions in these protected areas as they are identified to Tyvak through the coordination process with NTIA and/or the DoD. Tyvak will also comply with the restrictions indicated in Section 25.260 of the Commission's rules to the extent that the FCC concludes that such compliance is necessary given the minimal nature of Tyvak's proposed operations.

The National Oceanic and Atmospheric Administration (NOAA) operates systems in the 400.15-401 MHz band to collect meteorological data for weather forecasting systems, including radiosondes, rocketsondes, and dropsondes. Tyvak will avoid satellite and earth station transmissions in the areas where these systems operate during their daily periods of operation.

Tyvak will either comply with any restrictions imposed by NTIA or NOAA to facilitate such interference protection or coordinate directly with NOAA to ensure no harmful interference results.

In addition, the National Aeronautics and Space Administration ("NASA") uses the band for services involving the International Space Station ("ISS"). Tyvak understands, however, that these communications links involve very short transmission paths, *i.e.*, between the ISS and equipment operating either within or around the ISS. Therefore, it seems highly unlikely that Tyvak's brief communications between its earth stations and LEO satellite could interfere with these operations. Nevertheless, if NASA has concerns about such interference, Tyvak would be willing to consider refraining from conducting transmissions between its earth station and the Tyvak-0821 satellite during any period in which the ISS is within view of the earth station.

401-402 MHz Band

As noted previously in this narrative, the UHF communications system for the Tyvak-0261 will transfer telemetry data to associated earth stations using the 401.08 MHz band and both satellites will receive telecommand signals from earth stations using center frequencies of 401.08 MHz and 401.58 MHz, which are both within the 401-402 MHz frequency band. The 401-402 MHz frequency band is allocated internationally and in the United States for Meteorological Aids, Space Operation (space-to-Earth), Earth Exploration-Satellite (Earth-to-Space), Meteorological-Satellite (Earth-to-space). In the United States, these allocations are primary for Federal stations and, for non-Federal stations, the Meteorological Aids and Space Operation allocations are primary, while the remaining allocations are secondary.[12]

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[12] Pursuant to Footnote US64, the 401-406 MHz band is also available to Medical Device Radiocommunication Service (MedRadio) operations on the condition that harmful interference is not caused to stations in the meteorological aids, meteorological-satellite, and Earth

Earth-Exploration Systems

Planet Labs operates a fleet of Earth Exploration-Satellite Service ("EESS") NGSO satellites that is authorized to be as large as approximately 500 satellites, most of them at an orbit not exceeding 660 kilometers. The system is authorized to use portions of the 401-402 MHz (space-to-Earth) for TT&C operations. To support these operations, Planet Lab is authorized to operate a gateway earth station in Half Moon Bay, California, which is relatively close to Tyvak's San Diego earth station. Planet Lab's earth station, however, only uses the 401.27-401.33 MHz band for TT&C operations, which is sufficiently separate from Tyvak's frequency ranges of 401.0656-401.0944 MHz and 401.5656-401.5944 MHz to prevent the need for coordination between the two systems.

NVNG Systems

On November 18, 2021, Kinéis was authorized by the Commission to use the EESS allocation to operate a Non-voice, Non-geostationary ("NVNG") constellation consisting of 25 nanosatellites operating at an altitude of 650 kilometers in a sun synchronous (98° inclination angle) orbit that would use the 401-403 MHz band for uplink communications.[13] Kinéis indicated that it will use the 401-403 MHz band to extend the provision of environmental ARGOS services in the U.S. and worldwide. Kinéis has not reported the launch of any satellites to the Commission

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exploration-satellite services, and that MedRadio stations accept interference from stations in the meteorological aids, meteorological-satellite, and Earth exploration-satellite services.

[13] *See Kinéis*, IBFS File No. SAT-PDR-20191011-00113 (Call sign S3054).

and still has an application pending before the Commission to operate ground "beacons" in the United States that would transmit to its satellites using the 401-403 MHz band.[14]

Once Kinéis receives authority to operate terminal beacons and begins to launch its satellites, Tyvak will likely need to coordinate with it to ensure that Tyvak's brief bi-directional transmissions in the 401-402 MHz band, if they are still continuing by that point, do not interfere with its satellite network. Given Tyvak's need to transmit signals to and from its satellites only for relatively brief periods and only within view of its associated earth stations, Tyvak is confident that its proposed spectrum use can easily be coordinated with these satellite systems as they are launched.

Federal Systems

The Department of Commerce's National Environmental Satellite, Data, and Information Service ("NESDIS") operates the Geostationary Operational Environmental Satellites ("GOES") and Polar Orbiting Satellite ("POES") systems, which receive environmental monitoring data from numerous ground stations that is transmitted in the earth-to-space direction in the 401-402 MHz band. The GOES and POES systems as well as commercial satellites then re-transmit the information to a central processing center. In addition, NTIA reports that the Department of Defense operates radiosondes in the meteorological aids service "on a limited basis."[15]

Tyvak's operations within the 401-402 MHz band should have no impact on these Federal operations. Tyvak's earth-to-space operations at 401.08 MHz and 401.58 MHz will be extremely

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[14] *See Kinéis,* IBFS File No. SES-LIC-20220314-00271 (Call sign E220037).

[15] Radiosondes are expendable free-floating balloons transmitting data to the global meteorological community as an essential input to weather models and by researchers for atmospheric and climatologic research.

limited, consisting of hailing signals and brief instructions to the two satellites when they are in view of the associated earth stations. As noted previously, the 401-402 MHz band is already available in the United States in the earth-to-space direction for non-Federal EESS uplinks, is currently being used for this purpose by Planet Labs, Inc., and the Commission has approved this same use by Kinéis. Further, Tyvak is currently operating several other satellites using TT&C uplinks in the 401-402 MHz band without resulting in harmful interference to Federal systems, including Tyvak-0086 using a center frequency of 401.16 MHz,[16] Tyvak-0087 using a center frequency of 401.12 MHz.[17] and Tyvak-0129 using a center frequency of 401.205 MHz.[18] Therefore, Tyvak should be able to use its Fairbanks and San Diego earth stations to communicate with the Tyvak-0621 and -0262 satellites without resulting in harmful interference to federal systems.

Tyvak should also be able to use the 401.34 MHz frequency segment for space-to-earth links from its Tyvak-0262 satellite to associated ground stations without resulting in interference to any federal operations. As noted above, the 401-402 MHz band is allocated both in the U.S. and internationally for space-to-earth Space Operations in the 401-402 MHz band. Further, Planet Labs already uses a portion of this spectrum for telemetry downlinks from its fleet of EESS NGSO satellites. Therefore, the additional operation of telemetry downlinks for Tyvak's two satellites should not raise an interference concern for federal operations in this spectrum.

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[16] *See* OET Call Sign WJ2XZG, File No. 0016-EX-TC-2022.

[17] *See* OET Call Sign WJ2XZK, File No. 0017-EX-TC-2022.

[18] *See* OET Call Sign WK2XAJ, File No. 0015-EX-TC-2022.

S-band Spectrum Sharing

2050 MHz Band

As noted previously, the Tyvak-0-261 and -0262 satellites will receive payload operation instructions from Tyvak's Petaluma, California using S-band spectrum with a center frequency of 2050 MHz. The 2050 MHz frequency range is within the 2025-2110 MHz band, which is allocated internationally and in the United States for Space Operations, Earth-Exploration Satellite, and Space Research (all earth-to-space and space-to-space), although the allocations in the United States are limited to Federal operations. Pursuant to footnote US347, non-Federal earth-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 as long as they do not cause harmful interference to other authorized services. International and domestic allocations also exist in these frequencies for fixed and mobile services, which are used in the United States for television and cable auxiliary broadcasting and television relay.

Sharing with Fixed Broadcast Services

The 2025-2110 MHz band is heavily used in the United State for television auxiliary broadcasting, cable television relay and local television transmission, particularly around major cities within the United States. To address this use, Tyvak coordinated the operation of its S-band earth station in Petaluma with the Engineers for the Integrity of Broadcast Auxiliary Services Spectrum ("EIBASS") and the Northern California Frequency Coordinating Committee ("NCFCC") representing television broadcasters in Northern California. The resulting coordination agreements with these two entities have been submitted with this application. The request herein to use Tyvak's Petaluma earth station to transmit to the Tyvak satellites using a center frequency of 2050 MHz and a bandwidth of 28.8 kHz is consistent with the terms of this

coordination agreement. Further, Tyvak acknowledges that, regardless of the terms of its coordination agreements, it is obligated to ensure that its operations in the 2025-2110 MHz band must not cause harmful interference to primary operators in these frequencies and Tyvak will fulfill this obligation.

Sharing with Federal Services

The 2025-2110 MHz frequencies are used by NASA and NOAA, among other federal agencies, to operate and control numerous civil space missions. Most of the federal communications using the 2025-2110 MHz frequencies involve earth-to-space transmissions to satellites in geostationary orbit, such as links to the Tracking Data and Relay Satellite System ("TDRSS") and to the Geostationary Operational Environmental Satellites ("GOES"). Earth station transmissions to these satellites should not experience any interference from Tyvak's relatively low powered transmissions to the Tyvak-0261 and -0262 satellites in LEO.

Other government satellite systems, such as the Polar Operational Environmental Satellites ("POES") do operate in LEO orbit. To address this, Tyvak proposes to operate with a center frequency of 2050 MHz, which, as indicated in the chart below,[19] is in a portion of the 2025-2110 MHz band that is used by relatively few federal government satellite missions.

[19] *See NTIA Federal Government Spectrum Use Reports 225 MHz – 7.125 GHz*, available at https://www.ntia.doc.gov/files/ntia/publications/compendium/2025.00-2110.00_01DEC15.pdf (*last visited* Sept. 8, 2022).

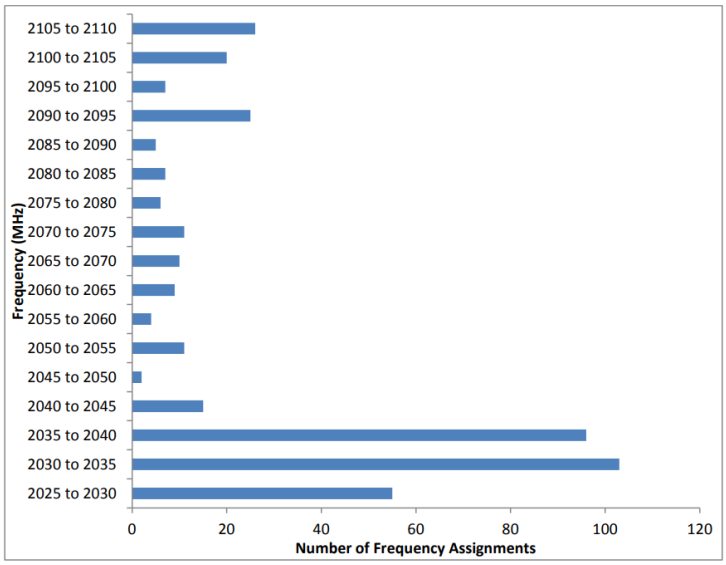

Figure 1. Distribution of Frequency Assignments in the 2025-2110 MHz Band

Tyvak acknowledges, however, that even with its selection of a relatively less used portion of the frequency band, Tyvak will need to coordinate with federal users of this spectrum to ensure that its proposed uplinks from its Petaluma, California earth station to the Tyvak-0261 and -0262 satellites do not result in harmful interference to federal operations.

2492 MHz Band

The payload on both satellites will use a center frequency of 2492 MHz to transmit payload telemetry data to two earth stations operated by Lockheed Martin in the United States. The 2492 MHz band is within the 2483.5-2495 MHz band, which is allocated for both federal and non-federal use in the United States for Mobile-Satellite and Radiodetermination-Satellite services, both in the space-to-earth direction. The sole commercial user of this spectrum for satellite services is Globalstar, which operates a Mobile-Satellite Service network that transmits to mobile end-user

devices via spot beams using the 2483.5-2500 MHz band for the downlinks.[20] Because of the brevity and infrequency of Tyvak's proposed transmissions, which will only be to two earth stations located in Waterton, Colorado and Camp Grayling, Michigan, and only when the satellites are within line-of-sight of the earth stations, Tyvak will be able to operate these downlink transmissions without resulting in harmful interference to end users of Globalstar's services.

X-band Spectrum Sharing

As noted above, The spacecrafts' X-band communications system will operate within the 8025-8400 MHz frequency band to downlink recorded payload data. Specifically, Tyvak-0261 will transmit with a center frequency of 8380 MHz and Tyvak-0262 will transmit with a center frequency of 8320 MHz.

All or portions of the 8025-8400 MHz band spectrum is allocated for the Earth Exploration-Satellite (space-to-earth), the Fixed, the Fixed-Satellite (earth-to-space), and the Meteorological-Satellite (earth-to-space) services. Pursuant to footnote US258, however, this spectrum is allocated in the United States on a primary basis for non-federal Earth Exploration-Satellite (space-to-earth) operations.

The Tyvak satellites will transmit in the X-band only when they are within line-of-sight of the receiving earth station in the United States, which is located in Petaluma, California, and only when they have received a communication from the earth station directing the spacecraft to initiate

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[20] *See* Spectrum and Service Rules for Ancillary Terrestrial Components in the 1.6/2.4 GHz Big LEO Bands, IB Docket No. 07-253; Review of the Spectrum Sharing Plan Among Non-Geostationary Satellite Orbit Mobile Satellite Service Systems in the 1.6/2.4 GHz Bands, Second Order on Reconsideration, Second Report and Order, and Notice of Proposed Rulemaking, 22 FCC Rcd 19733 (2007).

transmissions. Consequently, the spacecrafts will utilize the X-band only when in contact with specified earth stations. Given this very discrete and infrequent use, Tyvak should be able to coordinate its proposed operations with any co-frequency uses of the X-band in order to operate on a non-interference basis.

Further, although numerous operators have been licensed or provided market access by the FCC to use portions of the 8025-8400 MHz band, Tyvak has been unable to identify in the FCC's IBFS any satellite operators that have been authorized by the FCC to operate near 8320 MHz, which is the center frequency that will be used for the Tyvak-0262 satellite. Further, although the FCC has licensed a number of earth stations to transmit in the earth-to-space direction at or near 8380 MHz (which will be used by Tyvak-0261), Tyvak has been unable to identify any satellite systems that have been licensed or provided market access by the FCC to operate in the space-to-earth direction. Thus, the downlink transmissions from Tyvak's satellites to its earth station in Petaluma should not result in interference to any other satellite system.