Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
BlackSky Global LLC	)	File No. SAT-AMD-__________
	)	Call Sign S3032
Amendment to Application for		
Modification of License	)	
To Construct, Deploy and Operate an	)	
NGSO Earth Exploration	)	
Satellite Service Constellation System	)	

APPLICATION NARRATIVE

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APPLICATION NARRATIVE

I. Introduction and Overview

BlackSky Global LLC ("BlackSky"), by its attorneys and pursuant to Section 25.117 of the Commission's rules, hereby requests a modification of its blanket license ("License") for the construction, deployment, and operation of a non-geostationary satellite orbit ("NGSO")-like Earth Exploration Satellite Service ("EESS") constellation in order to allow it to expand its constellation to include the launch and operation of BlackSky's next iteration of satellites ("Gen-3").[1]

[1] BlackSky has pending an unrelated application to modify its constellation relative to its remaining Gen-2 satellites still to be launched. *See Public Notice*, Space Station Applications Accepted for Filing, BlackSky Global LLC, IBFS File No. SAT-MOD-20211230-00205, Report No SAT-01600 (rel. Jan 7, 2022) (the "Pending Mod"). Because of the existence of the Pending Mod, upon the advice of the Commission staff, this modification request is being styled as an amendment to the Pending Mod. So as not to delay needed action upon the Pending Mod, BlackSky requests that the Pending Mod (in its current form) be acted upon separately from the subject matter of this application.

BlackSky is currently licensed to operate a constellation of sixteen satellites.[2] This application requests authority for BlackSky to expand its constellation to up to thirty Gen-3 satellites. The Gen-3 satellites will be operated in conjunction with BlackSky's Global satellites currently in operation and ultimately replace them as they reach the end of their useful life. Authority therefore is requested both for the addition of the Gen-3 satellites to BlackSky's constellation and for the replacement of BlackSky's Global satellites with Gen-3 satellites without requiring a further Commission application.

The Gen-3 satellites will use communication links in the UHF, S-band, X-band, and L-band. Specific frequencies are noted in Section III B. This application includes an Orbital Debris Assessment Report ("ODAR") and Schedule S, which provides relevant technical information for BlackSky's Gen-3 satellites.

II. Public Interest Considerations

BlackSky is a provider of real-time geospatial intelligence. BlackSky provides on-demand and high frequency monitoring and artificial intelligence ("AI")-enabled analytics of the most critical and strategic locations, economic assets, and events on Earth. BlackSky's Software-as-a-Service ("SaaS") platform, Spectra AI, delivers automated alerts, data, and insights to customers, providing them with a first-to-know advantage that they use to support day-to-day decision making.

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[2] *See* Stamp Grant, FCC Call Sign S3032, IBFS File No. SAT-MOD-20190802-00070, May 27, 2020, as corrected on June 4, 2020.

Customers can access Spectra AI's data and analytics through easy-to-use web services or through platform application programming interfaces.

BlackSky's offerings are designed to support a broad range of government and commercial applications including national and homeland security, supply chain intelligence, crisis management, critical infrastructure monitoring, economic intelligence, and others. BlackSky's clients include the U.S. Department of Defense, the National Reconnaissance Office, and the National Geospatial-Intelligence Agency.

BlackSky's constellation is optimized to collect data on the most critical and strategic locations on Earth where the Company believes approximately 90% of the global GDP occurs. The orbital configuration of the constellation is designed. BlackSky satellites are designed with agile pointing capabilities that enable users to task the constellation on demand to collect data from specific locations of interest.

BlackSky's Gen-3 satellites will improve upon and eventually replace its existing satellites as they reach end of useful life. With increased payload and bus capabilities, BlackSky will be able to capture higher-resolution images across multiple spectral bands (visible SWIR[3]) with more frequent revisit rates. Through the development of BlackSky's Constellation, BlackSky will improve the services that it provides to users in two important ways: (i) by allowing BlackSky to direct and coordinate the focus of its observations on a particular area several times a day; and (ii) by making the provision

[3] Short-wave infrared imagery.

of such data more affordable to its customers. This expansion is fundamental to continue to serve BlackSky's customers and achieve BlackSky's objective of helping them to understand their environment in a world where the rate of change continues to increase.

Accordingly, an expeditious grant is in the public interest.

III. Technical Description

A. Design of the New Satellites

BlackSky's Gen-3 satellites are evolved from its Gen-2 design. The Gen-3 satellites enhance the payload design, reduce system latency, increase collection performance and system throughput, and maintain BlackSky's goals for operational flexibility and constellation resiliency.

B. Overview of Frequency and Spectrum Use

The frequency and spectrum on use for the Gen-3 satellites is built on the plan used for the Gen-2 satellites, with modifications to improve throughput, reliability, and commanding latency. These modifications include:

- Increased data rates for X-band downlinks to handle larger image sizes;
- Addition of X-band wide (asymmetric) beams to enable downlink while collecting imagery;
- Addition of Inmarsat L-band LEO-GEO cross link for "anytime" commanding;

- Additional UHF channels in the 400.15-401 MHz band to provide greater flexibility for federal coordination; and
- Starting no earlier than the second Gen-3 satellite, addition of an S-band omnidirectional downlink, to limit UHF downlink utilization to backup, including in the off-nominal circumstances described further below and for locations where S-band cannot be coordinated.

For convenience, the overall spectrum usage is summarized in Table 1 below

Table 1 Showing Overall Frequencies Employed

Link	Band	Frequency Range	Note
TT&C			
Primary TT&C (narrow) beam	X-band	8025-8400 MHz	Directional (narrow) antenna pattern, supports bandwidths of 165 and 330 MHz TT&C may be interleaved with payload downlink
Secondary TT&C (asymmetric) beam	X-band	8025-8400 MHz	Less directional (and asymmetric) antenna pattern, supports bandwidths of 165 and 330 MHz TT&C may be interleaved with payload downlink
Secondary TT&C downlink	S-band	2200-2290 MHz	Starting no earlier than the 2nd Gen-3 satellite. This will be used when X band antennas are not pointed at ground station and TT&C is required.

Link	Band	Frequency Range	Note
Backup TT&C downlink (for satellites with S-band downlink) Secondary TT&C downlink (for satellites without S-band downlink)	UHF	400.15-401 MHz 401-402 MHz	Same as Gen-2 with four (4) new channels added in 400.15-401 MHz
Inter-satellite transmit	L-band	1626.5-1660 MHz	via Inmarsat-4 GEO constellation
Primary uplink	S-band	2025-2110 MHz	Same as Gen-2
Backup uplink	UHF	449.75–450.25 MHz	Same as Gen-2
Inter-satellite receive	L-band	1525-1559 MHz	via Inmarsat-4 GEO constellation
Payload			
Primary (narrow) beam	X-band	8025-8400 MHz	Directional (narrow) antenna pattern, supports bandwidths of 165 and 330 MHz
Secondary (asymmetric) beam	X-band	8025-8400 MHz	Less directional (and asymmetric) antenna pattern, supports bandwidths of 165 and 330 MHz
GPS Receiver	L-band	1575.42 MHz	Receive-only

C. Coordination with Federal Agencies

BlackSky has initiated coordination with various federal agencies. The company is committed to supporting coordination with all federal agencies for operations in the bands for which the modified license is sought and has taken steps to initiate coordination ahead of submitting this application. BlackSky has identified several key considerations related to this coordination and addresses these in the following frequency-specific discussions.

D. Frequency Specific Considerations

i. 2025-2110 MHz

The primary commanding for Gen-3 TT&C will occur by S-band uplink in the 2025-2110 MHz band, which is the same as for BlackSky's Gen-2 satellites. This uplink will have the following parameters:

Center Frequency (MHz)	2071.875
Bandwidth (MHz)	0.200
Polarization	RHCP

Non-federal EESS (Space-to-Earth) may operate in the 2025-2100 MHz band, subject to such conditions as may be applied on a case-by-case basis. Transmission to satellites operating in this band shall not cause harmful interference to federal and non-federal stations operating in accordance with the U.S. Table of Frequency Allocations.[4] BlackSky will coordinate with federal and non-federal operators in this band to ensure compliance with this requirement.

[4] 47 C.F.R §2.106.

ii. **The 8025-8400MHz Band**

Gen-3 payload downlinks take place through one of two beams, primary (narrow) and secondary (asymmetric). During downlink through either of these beams, TT&C may be interleaved with the payload downlink. The primary (narrow) beam has the same directional radiation pattern as the X-band beam of Gen-2 satellites.

The secondary (asymmetric) beam has a less directional (lower EIRP) and asymmetric (about satellite roll axis) radiation pattern to allow payload downlinks at a greater variety of satellite attitudes. Though multiple asymmetric beam antennas may be present, only one will be selected to transmit at any given time.

Furthermore, a lower bandwidth (165 MHz due to lower symbol rate) signal is supported – on both the primary and secondary X-band beams – for improved link margin when downlinking to earth-stations with poorer performance (lower G/T) or other scenarios where link margin and/or earth-station compatibility must be improved.

	Primary (narrow) beam	Secondary (asymmetrical) beam
Center Frequency (MHz)	8200	8200
Bandwidth (MHz)	330, 165	330, 165
EIRP (dBW)	25.3	17.5
Polarization	RHCP	RHCP

The 8025-8400 MHz band is allocated to a number of services, including EESS (Space-to-Earth).[5] BlackSky's proposed use of the frequencies in this band is consistent with this allocation. The likelihood of interference is low due to the typically short transmissions (~10% of orbital period) and the low probability of one or more satellites belonging to different operators traversing the antenna beam of the receiving earth station and transmitting at the same time. BlackSky will coordinate its operations with other satellite operators to avoid such occurrences.

With regard to potential interference with NASA's operations, BlackSky will coordinate its expanded operations with NASA as it has done with its existing operations, reducing power from its satellites when directed toward particular earth stations or blanking transmission as necessitated by such coordination[6].

With respect to any potential interference with the Fixed Service, BlackSky demonstrates below that its satellite transmissions will meet the PFD limits specified by the ITU for the protection of the Fixed Service in this band.

Table 21-4 of the ITU Radio Regulations states that the power flux density (PFD) at the Earth's surface produced by emissions from an EESS space station in the 8025-

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[5] *Id*.

[6] To date, BlackSky has coordinated the operation of twenty earth stations with NASA. *See Appendix A to Letter* dated June 6, 2022, from Nick Merski, Chief Operating Officer, BlackSky Global LLC, to Marlene H. Dortch, Secretary, Federal Communications Commission, re BlackSky Global, LLC, Earth Exploration Satellite Service License, FCC Call Sign S3032; File No. SAT-LOA-20190314-00015.

8400 MHz band, including emissions from a reflecting satellite, for all conditions and for all methods of modulation, shall not exceed the following values:

- -150 dB(W/m^2) in any 4 kHz band for angles of arrival between 0 and 5 degrees above the horizontal plane;
- -150 + 0.5(d-5) dB(W/m^2) in any 4 kHz band for angles of arrival d (in degrees) between 5 and 25 degrees above the horizontal plane; and
- -140 dB(W/m^2) in any 4 kHz band for angles of arrival between 25 and 90 degrees above the horizontal plane.

The X-band PFD is calculated as follows:

- PFD [dB(W/m^2/ 4 kHz)] = EIRP density$_{max}$ (dBW/Hz) – 10log10(4πD^2) + 10log10(4·10^3)
- EIRP density$_{max}$ (dBW/Hz) is a measured value (via spectrum analyzer)
- D is slant range between the satellite and terrestrial receiver. It is a function of elevation angle.
- 10log10(4·10^3) scales power-flux density in dB(W/ m^2/Hz) to dB(W/m^2/ 4 kHz).

Figure 1 below illustrates the calculated PFD of the primary (narrow) X-band beam for the Gen-3 satellites flying at 385 and 450 km. 385 km is expected to be worst-case (lowest) altitude, though 450 km is the lower end of the planned typical altitude range (450-550 km). Furthermore, Figure 1 shows PFD values for both possible bandwidths – 165 and 330 MHz.

Figure 1 Primary (narrow) X-band beam PFD vs. elevation

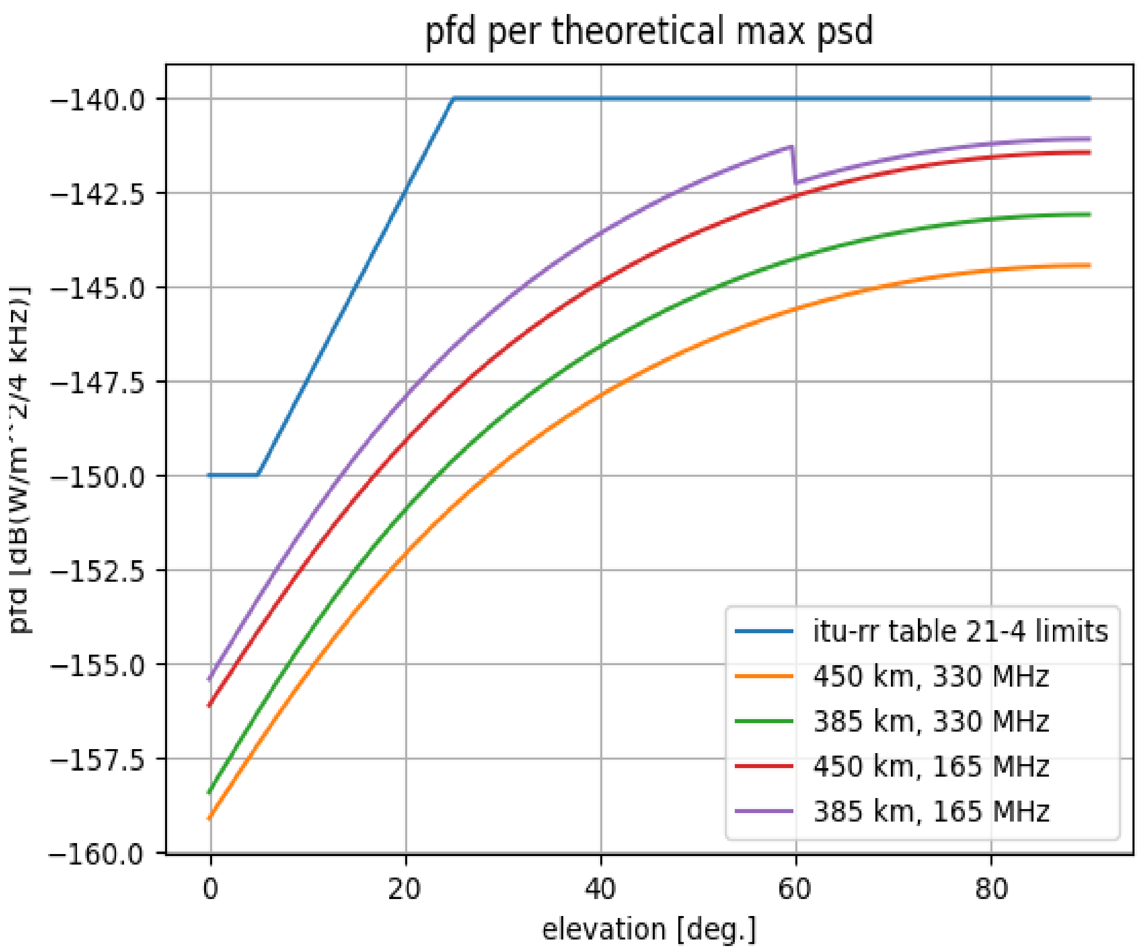
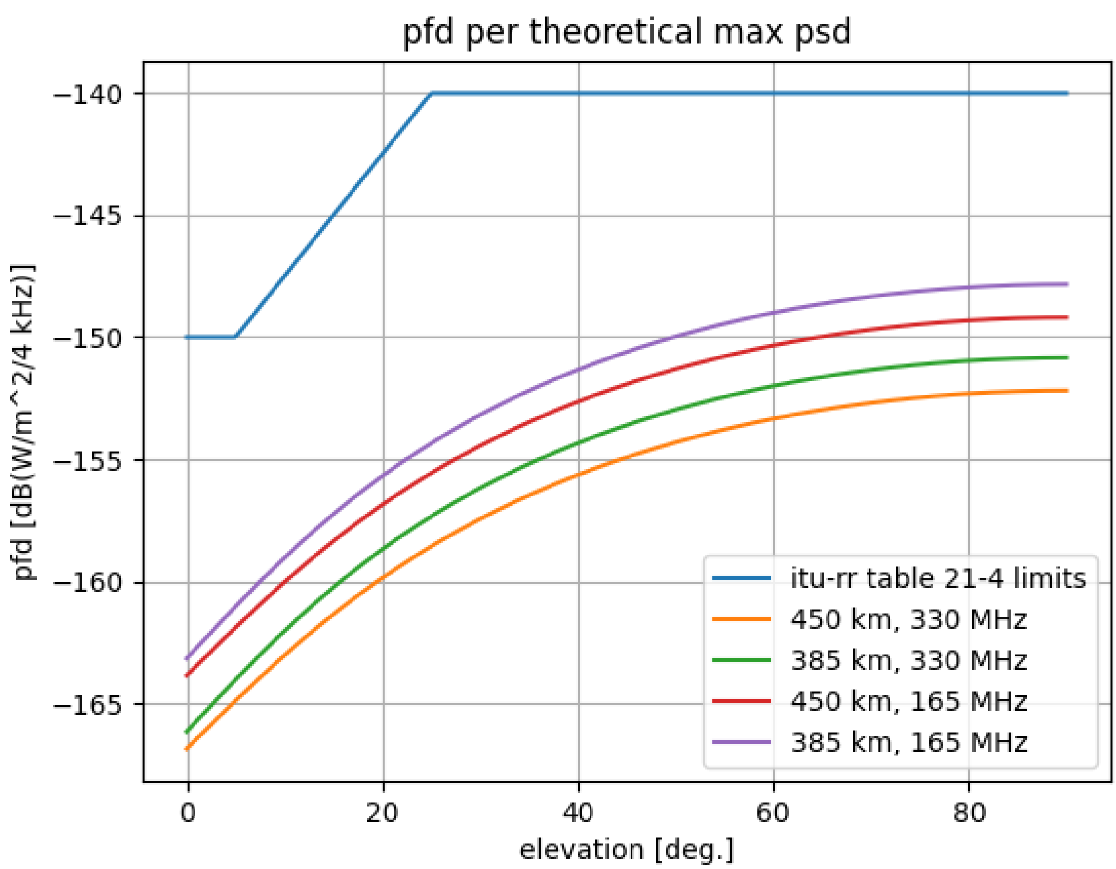


Figure 1 demonstrates compliance with Table 21-4 of the ITU Radio Regulations at the maximum output power of the transmitter for most beams. At an altitude of 385 km and bandwidth of 165 MHz, the PFD is expected to near the -140 dB(W/Hz/4 kHz) limit at elevations around 90 degrees. BlackSky will control X-band transmitter RF output power to ensure expected PFD levels comply with Table 21-4 of the ITU Radio Regulations (Figure 1 assumes maximum X-band transmitter RF output power) if such a circumstance arises. The 385 km, 165 MHz curve in Figure 1 (purple) shows a sudden drop at around 60 degrees elevation to demonstrate one possible method to ensure compliance with Table 21-4, namely lowering RF output power for certain satellite altitudes and/or elevation angles.

Figure 2 shows calculated PFD of the secondary (asymmetric) X-band beam at altitudes of 385 and 450 km, operating at both possible bandwidths of 165 and 330 MHz.

Figure 2 Secondary (asymmetric) X-band beam PFD vs. elevation



PFD levels from this beam's transmissions are expected to comply with Table 21-4 under all altitudes and elevations.

ITU Radio Regulations No. 22.5 specifies that in the 8025-8400 MHz band, which is shared by EESS, fixed-satellite service (Earth-to-Space), and the METS (Earth-to-Space), the maximum PFD produced at the geostationary satellite orbit ("GSO") by any EESS space station shall not exceed -174 dB(W/m^2) in any 4 kHz band. The calculation below shows that the PFD produced by the transmission from a Gen-3 satellite would not exceed that limit, even in the worst hypothetical case.

Using the worst case (*i.e.*, highest altitude) orbit of the Gen-3 intended constellation (550 km), the distance to the geostationary orbit would be 35,236 km. The maximum PFD (in dB(W/m^2/4 kHz)) at the GEO belt in a 4 kHz bandwidth is calculated in the following way:

- EIRP density$_{max}$ (dBW/Hz) – 10log10(symbol rate in baud) + 3 – 10log10(4π(35,236·10^3)^2) + 10log10(4·10^3)

The resulting max PFD values at the GEO belt are summarized in the table immediately below.

	Primary (narrow) beam, 330 MHz	Primary (narrow) beam, 165 MHz	Secondary (asymmetric) beam, 330 MHz	Secondary (asymmetric) beam, 165 MHz
GEO PFD [dB(W/m^2/4 kHz)]	-182.3	-179.3	-190.1	-187.1

Additionally, ITU-R SA.1157-1 prescribes terrestrial power spectral flux density limits of -255.1 dB(W/m^2/Hz) for protection of Deep Space terrestrial receivers operating in the 8.4 to 8.45 GHz band. Below it is shown that BlackSky Gen-3 satellites will not exceed these limits.

Parameter	**Value**	**Units**	**Notes**
Max radio output deep space PSD	-83.48	dB(W/Hz)	Measured
Min filter rejection	-75.00	dB	
Max deep space EIRP density	-143.23	dB(W/Hz)	Assumes max X-band gain (primary/narrow beam)
Spherical area	122.70	dB(m^2)	Sphere w/ radius = 385 km (worst-case: minimum slant range)
Terrestrial deep space power spectral flux-density	-265.94	dB(W/m^2/Hz)	EIRP - spherical area
ITU-R SA.1157-1 deep space power spectral flux-density limit	-255.10	dB(W/m^2/Hz)	
Margin	10.84	dB	

iii. **2200-2290 MHz**

The S-band 2200-2900 MHz band will be omnidirectional to be used for TT&C downlink purposes. It is intended to be used primarily when TT&C is required and the spacecraft is not pointing the X band antennas at the ground station. S-band use includes off-nominal operations, *e.g.,* in LEOP, when a satellite may be tumbling after being separate from the launch vehicle, or in the case of an uncontrolled anomaly when a link cannot be closed with a directional antenna pattern. The S-band downlink is being added to replace UHF omnidirectional downlink in most scenarios, significantly reducing utilization of the 400.15-401 MHz and 401-402 MHz bands.

Due to manufacturing constraints, concerns over the timing of coordination and final frequency selection, the S-band TT&C downlink hardware will not be installed on all Gen-3 satellites. This link will be flown on the Gen-3 bus no earlier than the second satellite. Exact timing of the S-band capability insertion will be determined after coordination is completed for use of the band.

BlackSky is seeking authorization for two distinct channels for S-band downlink in order to maximize flexibility in addressing any interference concerns that may arise during the coordination process. The frequencies 2249 and 2258 MHz have been selected in an attempt to minimize interference potential, however final frequency selections can be adjusted if coordination establishes better options.

Parameter	**S-band Downlink**
Center frequency	2249, 2258 MHz
Necessary bandwidth	0.46 MHz
Max EIRP	4.1 dBW
Polarization	RHCP

Though S-band is allocated on a primary basis for Space Operations and EESS space-to-earth internationally, it is only allocated for federal use in the United States Table of Frequency Allocations[7] . However, there is some industry precedence of federal coordination in this frequency band for commercial use for coordinated earth stations outside of the United States and its possessions, including for EESS operations.[8] BlackSky will undertake similar coordination with NTIA and other federal agencies in order to enable its use, including, if necessary limiting its use to communications with earth stations that are located outside of the United States and its possessions.

Allowing BlackSky to use the S-band for the omnidirectional downlink TT&C operations described above will permit BlackSky to limit even further its use of the UHF band, as set forth below. BlackSky has determined that the S-band is the best available alternative for it to accomplish this goal.

iv. 401-402 MHz Band

The 401-402 MHz band is currently used by BlackSky for secondary TT&C downlink operations, subject to a number of license conditions designed to protect NOAA operations in the band. As discussed above, BlackSky plans the addition of an

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[7] 47 C.F.R. §2.106.

[8] *See, e.g.*, Stamp Grant, Loft Orbital Solutions Inc., FCC Call Sign S3052, IBFS File Nos. SAT-LOA-20190807-00072 and SAT-AMD-20200527-00063 (granted Oct 8, 2020) (*cf*. Loft Orbital Solutions Inc., Application for Authority to Launch and Operate a NGSO in the EESS, IBFS File Nos. SAT-LOA-20190807-00072, Narrative at p.16.). *See also*, Stamp Grant, Spire Global, Inc., FCC Call Sign S2946, IBFS File No. SAT-LOA-20151123-00078 as modified and reissued SAT-MOD-20200603-00065 (granted Sep 18, 2020)."

S-band downlink to its Gen-3 satellites, in order to further limit BlackSky's use of the 401-402 MHz band. In particular, in order to address NOAA concerns over BlackSky's continued operations in the band, once S-band is installed on BlackSky's Gen-3 satellites, BlackSky can limit its use of the 401-402 MHz band to the following scenarios:

- To maintain omnidirectional TT&C downlink wherever coordination for use of omnidirectional S-band TT&C downlink is not feasible;
- When uncertainty in satellite ephemeris is so great that use of UHF ground antennas (with large beamwidths) is required in order to communicate with the satellite; and
- Hardware anomaly or failure of S-band TT&C downlink.

In other words, UHF is retained as a backup in order to maintain omnidirectional TT&C downlink, which is critical for safe operation of the Gen-3 satellite. UHF is to be used only when other bands are not available or not suitable for the specific issue.

In addition, Gen-3 satellites will limit use of the 401-402 MHz band to an operational duty cycle of less than 1% as averaged over a 90-day period.

Finally, BlackSky notes that the 401-402 MHz band is allocated to several services, including Space Operation (Space-to-Earth).[9] BlackSky's proposed use of the frequencies in this band is consistent with this allocation.

[9] 47 C.F.R. §2.106.

v. 400.15-401 MHz

As part of BlackSky's effort to minimize use of the 401-402 MHz band, BlackSky seeks to include four new frequency channels in the 400.15-401 MHz band (in addition to its currently licensed channel at 400.875 MHz) for TT&C downlink use. Particulars of this use are shown below:

	Downlink
Center Frequency (MHz)	**Existing:** 401.5, 401.4375, 401.375, 401.225, 401.155, 401.085, 401.015, 400.875 **New:** 400.945, 400.805 400.735, 400.665
Bandwidth (MHz)	0.030
EIRP (dBW)	6.7
Polarization	Linear

The 400-401 MHz band is allocated to several services, including Space Operation (Space-to-Earth) as a secondary allocation, subject to compatibility analysis and coordination requirements.[10] BlackSky's proposed use of the frequencies in this band is consistent with this allocation. BlackSky understands that any grant permitting operation on this frequency would be subject to such requirements, but has added the

[10] *Id*. at n. US 324.

capability to operate on this frequency to allow maximum flexibility in efforts to move away from the 401-402 MHz band, given the interference concerns there.

However, there exist a number of frequency coordination concerns in this band due to its use by federal and MSS operators. For this reason, BlackSky is also pursuing an omnidirectional S-band TT&C downlink.

vi. **449.75-450.25 MHz**

As is the case with its Gen-2 satellites, BlackSky plans to use the 449.75-450.25 MHz band for a backup TT&C uplink. The parameters of this use are shown below

	Uplink
Center Frequency (MHz)	450.2
Bandwidth (MHz)	0.030
Polarization	RHCP

The 449.75-450.25 MHz may be used by federal and non-federal stations for space telecommand (Earth-to-space) at specific locations, subject to such conditions as may be applied on a case-by-case basis. [11] BlackSky's proposed use of the frequencies in this band is consistent with the guidance in US Table note 87 and has designed the carrier frequency close to 450 MHz (450.2 MHz) as possible. Internationally, BlackSky will

[11] *See* 47 C.F.R. § 2.106, n. US 87.

comply with the requirements for such use that are stated in International Table footnote 5.286.

vii. 1525-1559 and 1626.5 and 1660 MHz

For its Gen-3 satellites, BlackSky plans to utilize a spaceborne Inmarsat BGAN terminal operating in L-band (1525-1559 and 1626.5 and 1660 MHz). This makes possible communications with the Gen-3 satellite over the Inmarsat-4 GEO satellite constellation even when the Gen-3 satellite is not over a BlackSky earth-station. Such inter-satellite links allow for immediate ("anytime") tasking of the Gen-3 satellite, in addition to "anytime" collecting of satellite engineering telemetry.

The spaceborne Inmarsat BGAN terminal will receive from the Inmarsat-4 GEO constellation between 1525 and 1559 MHz, and will transmit to the Inmarsat-4 GEO constellation between 1626.5 and 1660 MHz. Inmarsat transmit and receive channels do not exceed 200 kHz. The center frequency of the 200 kHz (max) channel will be negotiated between the terminal and Inmarsat BGAN, as per Inmarsat radio communications protocols.

	Inter-satellite receive	Inter-satellite transmit
Center Frequency (MHz)	Selected by Inmarsat. In 1525-1559 MHz range.	Selected by Inmarsat. In 1626.5-1660 MHz range.
Bandwidth (MHz)	Selected by Inmarsat. Not to exceed 0.2 MHz	Selected by Inmarsat. Not to exceed 0.2 MHz
EIRP (dBW)	N/A	10
Polarization	RHCP	RHCP

The signals transmitted from BlackSky's Gen-3 satellites are within the frequency range authorized to Inmarsat and as permitted for BlackSky's use by Inmarsat. Inmarsat will use its own licensed network to transmit and receive signals from the BlackSky Gen-3 satellites and is responsible for securing all necessary regulatory authority to do so. BlackSky's use of this band is in accordance with and will be coordinated with Inmarsat's requirements, and operations will be conducted on a non-interference basis.

E. **Orbit Information**

The BlackSky satellites need to operate in a range of orbits in order to achieve high revisit rates. The exact orbits into which the satellites will be injected and later operated is also a function of the launch missions that will be available for the satellites. Each satellite has a design life of approximately five (5) years. To allow BlackSky sufficient flexibility to accommodate launch mission, BlackSky requests authorization for its Gen-3 satellites to be deployed anywhere from 385 to 550 kilometers in altitude and at inclinations between 35 – 60 deg or in a Sun Synchronous (SSO) orbit (~97 deg).

Launch arrangements for Gen-3 satellites are currently pending.

F. Earth Stations

Earth stations currently planned for use with the constellation are as follows:

Name of Station	Address	Coordinates	Frequency Bands
Awarua Plains New Zealand	781 Colyer Road, Awarua Plains 9877, NEW ZEALAND	46° 31′ 43″ S 168° 22′ 52″ E	UHF Uplink UHF Downlink S Uplink S Downlink X Downlink
Svalbard Norway	SvalSat Platåberget PB 458 9171 Longyearbyen, NORWAY	78° 13′ 54″ N 15° 22′ 38″ E	S Uplink S Downlink X Downlink
Usingen Germany	Erdfunkstelle 1 61250 Usingen, GERMANY	50° 19′ 51″ N 08° 28′ 16″ E	UHF Uplink UHF Downlink S Downlink S Uplink X Downlink
Harmon Guam	497 Harmon Loop Rd. Dededo, Guam 96929	13° 30′ 49″ N 144° 49′ 31″ E	UHF Uplink UHF Downlink S Uplink X Downlink
Chitose Japan	1007-261 Izumisawa Chitose City Hokkaido 066-0051, Japan	42° 46′ 28″ N 141° 37′ 28″ E	UHF Uplink UHF Downlink S Uplink S Downlink X Downlink
Nemea Greece	6th km Petriou- Korinthias Rd, 20500 Nemea, Korinthias, Greece	37° 50′ 43″ N 22° 37′ 25″ E	S Uplink S Downlink X Downlink
Hartesbeesthoek South Africa	SANSA Farm No 502JQ, Hartebeesthoek, District Krugersdorp, South Africa	25° 53′ 08″ S 27° 42′ 20″ E	S Uplink S Downlink X Downlink
Longovilo Chile	Camino a Rapel Km. 42 San Pedro, Region Metropolitana, Chile	33° 57′ 22″ S 71° 24′ 04″ W	UHF Uplink UHF Downlink S Uplink S Downlink X Downlink

Name of Station	Address	Coordinates	Frequency Bands
Brewster Washington	66c Teleport Dr. Brewster, WA 98812	48° 08′ 44″ N 119° 42′ 04″ W	UHF Uplink UHF Downlink S Uplink X Downlink
Punta Arenas Chile	Ruta 9 Norte S/N, KM 29, Cabo Negro Punta Arenas Chile	52° 56' 06" S 70° 52' 15" W	S Uplink S Downlink X Downlink
Jeju South Korea	304ho, 2708-19, Iljudong-ro, Gujwa-eup, Jeju-si, Jeju-do, Republic of Korea 63359	33° 32' 27" N 126° 48' 57" E	S Uplink S Downlink X Downlink
Cheonan South Korea	South Korea, Chungcheongbuk-do, Cheongju-si, 청원구 내수읍 오창대로 980	36° 42′ 59″ N 127° 29′ 57″ E	UHF Uplink UHF Downlink S Uplink S Downlink X Downlink
Savanne Mauritius	Mauritius Telecom Landing Station Sante Marie Baie Jacotet, Mauritius	20° 30' 2" S 57° 27' 2" E	S Uplink S Downlink X Downlink

BlackSky's service is still developing and it is anticipated that ground stations will be added in the future, subject to such conditions as the Commission may specify.

G. Form 312 Schedule S Requirements

As the launches and corresponding orbital parameters for the Gen-3 satellites are still to be determined, BlackSky is able to provide only representative information for certain sections of this Schedule S modification application. If, and to the extent required, BlackSky requests a waiver of Section 25.114(c) of the Commission's rules to the extent that to accommodate such launch flexibility its Schedule S submission does not fully conform to that rule's requirements.

Additionally, BlackSky offers the following clarifying points regarding the information in the Schedule S and, if and to the extent so required, asks that its requested waiver of Section 25.114(c) cover these matters as well.

All receiving and transmitting beams have been denoted as "Steerable" to communicate that the beam orientation/pointing within a coverage area (area where satellite has visibility to a BlackSky earth-station) will vary due to varying satellite attitude. In other words, the beams' peak antenna gain will not always be pointed at nadir. The nature of this variation is different among the beams as follows:

- UHF and S-band transmit/receive beams, having omnidirectional antenna patterns, do not require a specific satellite attitude in order to close the datalink. Since satellite attitude varies throughout its orbit it follows that the terrestrial antenna gain contours will vary according to satellite attitude/pointing.
- For X band narrow beam downlinks, the satellite will maintain an attitude such that the boresight of its directional antenna is pointed at the receiving earth-station (angle between antenna boresight and nadir varies during downlink)
- For X band asymmetric beam downlinks, the satellite will clock to keep the max gain in the narrow axis of the pattern, while the broad axis of the beam will be controlled by the required angle of the telescope.

Note that final UHF transmit/receive and S-band transmit antenna patterns, as integrated on the Gen-3 satellite bus, are not yet available, so contour plots are derived from Gen-2 antenna patterns, which are anticipated to be substantially equivalent. More particularly:

- Patterns for the UHF whip as integrated on the Gen 3 satellite bus are currently being modelled. Though major characteristics such as max or average gain are not expected to change significantly as the same whip antenna is planned, the exact way the RF interacts with the Gen 3 bus will be different then Gen 2 bus and the resulting spatial distribution of peaks and nulls will shift. Note that in either case, UHF is typically used without specific pointing of the spacecraft, and the contour plots assume nadir pointing, so with both Gen 2 and Gen 3 spacecraft, realized earth contour plots are expected to vary as a function of spacecraft attitude.

- The Gen 2 S-band antenna is optimized for the 2025-2110 band and will need to be modified to support both the uplink frequency and downlink in the 2200-2290 bands. Evaluation of similar modifications reveals that similar performance to the current antenna is achievable, though may not achieve as high of gain or as broad of a beam as currently optimized so use of Gen 2 patterns for both is conservative. Final modifications will be established after coordination of specific downlink frequencies is completed.

- X band patterns (both narrow beam and asymmetric beam) are representative of the antenna models baselined for the Gen 3 satellites.

BlackSky will submit an amendment to its application at such time as additional information about the antenna patterns is available.

Regarding the UR, UT1, and UT2 beams, this expected variation of satellite attitude implies a non-constant angle between the linear polarization of these beams and the equatorial plane. Schedule S only allows a single value be entered for this angle, so BlackSky cannot adequately represent the non-constant angle between the UR, UT1, and UT2 beam polarizations and the equatorial plane. A value of 0 degrees was chosen as this is expected to be the most typical angle.

Regarding the X-band beams: both narrow (primary) and asymmetric (secondary) beams support (2) bandwidths each (165 and 330 MHz), resulting in four channels/beams reflected in the schedule S. The table below maps both the beams, channels, and bandwidths. All beams and channels share the same transmitter via an RF switch so only one can be active at a time. Since the different bandwidths imply different power flux-density and EIRP density values, four beams in the Schedule S were introduced for clarity

Antenna	Bandwidth	Transmitting Beam	Channel
Narrow (primary) beam	330	XTNH	XN1
	165	XTNL	XN2
Asymmetric (secondary) beam	330	XTAH	XA1
	165	XTAL	XA2

Regarding the LR1 receiving channel. The bandwidth and center frequency (34 and 1542 MHz, respectively) were selected to reflect the operating frequency range of 1525-1559 MHz of the LR beam. However, the actual communications channel uses channels at a variety of center frequencies that are 200 kHz wide (both transmit and receive), maximum. Similarly, the LT1 transmit channel is listed with a bandwidth of 33.5 MHz and center frequency of 1643.25 MHz to reflect operating frequency range of 1626.5-1660 MHz.

Regarding the service area descriptions of "Visible earth" for beams SR, UR, XTNH, XTNL, XTAH, XTAL, UT1, UT2, and ST: this denotes the fact that BlackSky earth-stations are not strictly restricted to certain geographical areas and thus Gen-3 transmission/reception may occur virtually anywhere within "Visible earth".

With regard to the Orbital Planes defined in the Schedule S, the listed Orbital planes are representative for the range of altitudes and inclinations that may be employed. BlackSky plans for typical altitudes of 450-550 km and inclinations of 37 to 60 degrees, though launch and operation outside these ranges is possible. That is to say, the actual orbital parameters may vary from the values currently represented in Schedule S depending on launch opportunities, but operation will remain within the ranges shown in /section III.C above; *i.e.,* from 385 to 550 kilometers in altitude and at inclinations between 35 – 60deg or in an SSO orbit (~97 deg).

IV. Orbital Debris Mitigation

BlackSky has prepared an Orbital Debris Assessment Report ("ODAR") as informed by NASA-STD-8719.14, which is attached as a separate exhibit ("Exhibit 2"). As discussed in the submitted ODAR, BlackSky's Gen-3 satellites are compliant with all applicable orbital debris requirements.

BlackSky has improved the fidelity of ODAR modeling since the original Gen-2 application and has sought to implement many design principles to reduce the probability of satellite debris reaching Earth or remaining in orbit. These design principles have produced ODAR results for Gen-3 that are not only compliant, but are substantially improved over BlackSky's prior Gen-2 design, despite a nearly three times increase in mass and volume for Gen-3 satellites relative to the Gen-2 satellites. Design choices that reduce risk of debris include:

- Failure modes and effects analyses (FMEA) have been performed for Gen-3's high energy systems to reduce the probability of debris from normal operations and/or explosions. Mitigations were implemented for these systems – specifically batteries and propellant tanks – including current limiting on all circuits, and conservative factors of safety for pressurized tanks.

- A high-thrust Hall-Effect Thruster was selected to support collision avoidance maneuvers on orbit. This capability, coupled with our robust automated close approach prediction processes, reduce the probability of collision with known objects on orbit.

- Specific design-for-re-entry-demise features included in the Gen-3 satellites include:

  - Limiting the use of materials that may survive re-entry, such as titanium, silicon carbide, invar and others. BlackSky materials that are entry-resistant (including titanium and zerodur) are limited to applications where the Coefficient of Thermal Expansion ("CTE") and/or strength-to-weight ratio is required to meet mission requirements. Where not required, BlackSky accepted mass growth (by using aluminum, for example) to achieve a higher probability of demise.

  - Limiting the number of pieces expected to survive re-entry. BlackSky uses entry-resistant fasteners to secure entry resistant structures in order to increase the probability that these structures re-enter as a monolith. This reduces the debris footprint and the resulting probability of impact.

  - Emphasis on building thin wall structures for major payload components, which facilitates demise during re-entry.

  - Software that enables decommissioning and draining of onboard stored energy sources.

V. Waiver Requests

A. Modified Processing Round Rules

BlackSky requests waiver of Sections 25.156 and 25.157 of the Commission's rules, which provide for the processing of "NGSO-like satellite systems" under a modified processing round framework. BlackSky requests instead that this Application be processed pursuant to the first-come, first-served procedure adopted for "GSO-like satellite systems" under Section 25.158 of the Commission's rules.

The Commission previously granted waiver of the modified processing round requirement with respect to BlackSky's Gen-2 satellites,[12] as well as with respect to numerous other EESS operators, each premised on a showing that such operators would be capable for sharing with current and future NGSO systems operating in the same frequency bands.

As with EESS NGSO applications previously granted, grant of BlackSky's application would not prevent subsequent applications from using the spectrum, grant of the waiver would not undermine the policy objectives of the rule and, as shown herein, would otherwise serve the public interest. Accordingly, good cause exists to waive the modified processing round rules.[13]

B. Default Service Rules

While it is not clear that the Commission's default service rules would apply in any event, if they might otherwise be deemed applicable, BlackSky requests a waiver of the default service rules under Section 25.217(b) of the Commission's rules. Although the Commission has not adopted band-specific rules for EESS NGSO operations, the Commission has granted waivers of the default service rules contained in Section

[12] *See* Stamp Grant, BlackSky Global LLC, FCC Call Sign S3032, IBFS File No. SAT-LOA-20180320-00023 (granted October 3, 2018, as corrected on Oct. 28, 2018); Stamp Grant, BlackSky Global LLC, IBFS File No. SAT-MOD-20190314-00015 (granted May 16, 2019); Stamp Grant, BlackSky Global LLC, IBFS File No. SAT-MOD-2019-0802-00070 (granted May 27, 2020, as corrected on June 4, 2020).

[13] *See WAIT Radio v. FCC*, 418 F.2d 1153, 1157 (D.C. Cir 1969).

25.217(b) to NGSO EESS system licensees on multiple occasions, based on the fact the EESS operators are required to comply with technical requirements in Part 2 of the Commission's rules and applicable ITU rules.[14] For these same reasons, if required, the Commission should grant BlackSky a waiver of the default service rules contained in Section 25.217(b).

C. Milestone and Bond Requirements

BlackSky already has met the milestone and bond requirements of its current license. As noted above, fifteen of the authorized sixteen satellites already have been launched, fourteen of which are in operational service, and three additional Gen-2 satellites (two of which will be replacement satellites) have been constructed and are awaiting launch later this year or early next. Given this record of performance, BlackSky urges that no new bond should be required for the expansion of its system, consistent with treatment of other similarly situated NGSO systems seeking to expand their constellations.

D. Non-Conforming Frequency Use.

BlackSky requests a waiver of Sections 2.102(a) and 2.106 of the Commission's rules in order to permit it to operate on the following frequency or frequency bands for

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[14] *See Space Imaging Order*, 20 FCC Rcd at 11973-74¶¶ 26-31; *DigitalGlobe, Inc.,* Order and Authorization, 20 FCC Rcd 15696 ¶¶ 1, 15 (2005); *see also* Planet Labs, Inc., SAT-MOD-2015-0802-0053 (granted Sept. 15, 2016), SAT-LOA-20130626-0087 (granted Dec.3, 2013); Skybox Imaging, Inc., SAT-LOA-20120322-00058 (granted Sept. 20, 2012).

which its operations would constitute a non-conforming use with the Table of Frequency Allocations:

(i) 2200-2290 MHz (downlink); and

(ii) 1525-1559 and 1626.5 and 1660 MHz (transmit and receive, inter-satellite links between the Gen-3 satellites and the Inmarsat-4 GEO satellite constellation)

BlackSky's need for these operations, both to improve its service to its customers and to limit its use of the 401-402 MHz band which, while conforming, has raised interference concerns with NOAA, demonstrates that the public interest will be served by granting this waiver request.

In addition to the Commission's general public interest standard for waiver requests, specifically with regard to waiver requests to permit non-conforming uses, the Commission has stated many times that it "may grant a waiver of the Table of Frequency Allocations for non-conforming uses of spectrum when there is little potential for interference into any service authorized under the Table of Frequency Allocations and when the non-conforming operator accepts any interference from authorized services."[15]

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[15] *Application for Modification of License to Authorize a Second-Generation NGSO MSS Constellation by Iridium Constellation LLC*, Order and Authorization, 31 FCC Rcd 8676 (IB 2016)("*Iridium Order and Authorization*"). *See also, Applications by Orbcomm License Corp. For Authority to Modify its Non-Voice, Non-Geostationary Satellite System et al.*, Order and Authorization, 23 FCC Rcd 4804, 4809, para. 15 (IB/OET 2008).

Here, BlackSky, by operating within the limits described in Sections III. D, plus agreeing to accept interference from any authorized service, satisfies this standard.

VI. Other Matters

A. International Telecommunication Union Filing

BlackSky is preparing the ITU filing information as required under Section 25.111(d) of the Commission's rules and will provide an electronic file with this information to the Commission. Attached as Exhibit 4 is an ITU cost-recovery letter associated with this modification application.[16]

B. NOAA Authorization

BlackSky will submit a license application to NOAA to reflect the changes that are presented in this Application. BlackSky will notify the Commission when NOAA has approved the NOAA license application.

VII. List of Exhibits

1. Application Narrative
   i. Attachment A: Certification
2. Orbital Debris Assessment Report (ODAR)
3. Ownership
4. ITU Cost Recovery Letter

[16] The exhibit is a draft since the required file number is not assigned until after filing. Once this application is filed, a cost recovery letter will be submitted with the appropriate file number.

VIII. Conclusion

For the reasons set out above, BlackSky respectfully requests modification of its license. Grant of BlackSky's application for modification of its License is in the public interest and it is respectfully requested that the Commission grant the application expeditiously.

Respectfully submitted,

/s/ Chalinee Tinaves

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ATTACHMENT A

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in this application and associated attachments, that I am familiar with Part 25 of the Commission's rules, that I have either prepared or reviewed the engineering information submitted in this Application and that it is complete and accurate to the best of my knowledge and belief.

/s/ *Nick Merski*
Nick Merski
Chief Operating Officer