Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Orbital Sidekick, Inc.	)	File No.
	)	
Application for Authority to Launch and Operate a Non-Geostationary Satellite Orbit System in the Earth-Exploration Satellite Service	)	Call Sign:

APPLICATION

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TABLE OF CONTENTS

Page

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APPLICATION

Orbital Sidekick, Inc. ("OSK") requests authority from the Federal Communications Commission (the "Commission") to launch and operate a six-satellite hyperspectral imaging non-geostationary orbit ("NGSO") constellation in Low Earth Orbit ("LEO"), known as Global Hyperspectral Observation Satellite ("GHOSt"). Pursuant to Sections 25.114 of the Commission's rules, a completed Form 312, Schedule S, and Technical Annex are included with this Application.[1]

I. BACKGROUND AND DESCRIPTION OF OSK SERVICES

OSK, a San Francisco, California operator of space-based hyperspectral monitoring sensors, provides innovative remote sensing solutions for a diverse set of industrial and governmental customers, including end users across the energy, surveying and extraction, agriculture, environmental monitoring, and defense sectors. OSK's proprietary analytics platform and hyperspectral payload architecture provide persistent space-based monitoring solutions powered by the Spectral Intelligence Global Monitoring Application (SIGMA™) platform, a unique radiometric speciation and change detection capability that enables unparalleled target monitoring services for both commercial and defense users on a global scale. The SIGMA™

[1] 47 C.F.R. §§ 25.114.

platform can apply computationally efficient change detection and supervised classification machine learning algorithms to detect differences in the spectral signatures of each pixel as a function of time, and allows OSK to correlate these changes to its ever-expanding spectral library to chemically classify the basis for that change. Examples of the kinds of data sets OSK provides its customers include protein content and evapotranspiration levels for crops, corrosion identification and leak detection for monitoring pipelines, accurate mineral surveying, environmental monitoring for various applications, and real-time road/rail infrastructure conditions.

The GHOSt constellation represents the next evolution of OSK's sensing capabilities and will allow OSK to scale its commercial product with larger coverage, reduced revisit times, better spatial resolution, and more spectral capability.[2] GHOSt will capture more than 400 spectral bands in the visible to shortwave infrared range of 400-2500 nm to feed OSK's SIGMA™ platform. Therefore, OSK respectfully requests the Commission expeditiously grant this NGSO application so that OSK may commence commercial operations and further expand its innovative offerings to its diverse set of customers.

II. DESCRIPTION OF SYSTEM FACILITIES AND OPERATIONS

A. Space Segment

The GHOSt mission will involve deploying a remote sensing constellation of small satellites with both radiofrequency and optical payloads. The satellite constellation will consist of six (6) technically identical satellites launched into a sun-synchronous orbital ("SSO") inclination

[2] OSK does not hold any Commission authorizations. OSK previously filed an application substantially similar to the instant proposed operations pursuant to the Commission's streamlined licensing procedures, which was voluntarily withdrawn by OSK and concurrently replaced with the instant application upon the advice of the International Bureau. *See* File No. SAT-LOA-20211217-00198.

in LEO.[3] The spacecraft bus is based on Astro Digital's flight-proven Corvus-XL smallsat platform and utilizes Astro Digital's heritage flight computer, attitude determination and control system, power, and communications subsystems. The payload for each satellite consists of a proprietary hyperspectral imager manufactured by OSK. Each satellite has external dimensions of 57.8 cm x 57.8 cm x 111.4 cm and a total mass of 91.4 kg.[4]

As described more fully in the accompanying orbital debris assessment report ("ODAR") and Technical Annex, each satellite is equipped with state-of-the-art hardware and software solutions to ensure safe and efficient mission operations. Each GHOSt satellite will be capable of making orbital adjustments and performing collision avoidance maneuvers by utilizing differential drag, but will not carry propulsive systems.[5]

The GHOSt system plans to operate in the radiofrequency bands outlined in the table below. Satellite downlink transmissions can be turned on and off by ground telecommand in compliance with Commission rules.[6]

Type of Link and Transmission Direction	**Frequency Ranges**
EESS Downlink	25.5 – 27.0 GHz
EESS and TT&C Uplink	2025 – 2110 MHz
Inter-Satellite Service (Transmit)	1615 – 1617.5 MHz
Space Operations Service Downlink (TT&C)	400.15 – 401 MHz
GPS Signals	L1 C/A, L1C, L2C, L2P, L5

[3] The GHOSt-01 and GHOSt-02 satellites will each have one additional Ka-band antenna, known as a Lens Aided Horn, which has a lower peak gain. *See* Attachment B - Technical Annex, § A.3 ("Technical Annex").

[4] *See* Attachment C – Orbital Debris Assessment Report at 2-4 ("ODAR").

[5] ODAR at 8-9.

[6] *See generally* Technical Annex; 47 C.F.R. § 25.207.

B. Orbital Information

The GHOSt satellites described in this application will operate at an altitude of 525 km in a SSO inclination.[7] The information below describes the anticipated orbital characteristics for the GHOSt constellation.

Orbital Plane Number	1	2	3
Number of Satellites within the Orbital Plane	2	2	2
Inclination Angle	97.5°		
Orbital Period	5708 seconds		
Apogee	525 km		
Perigee	525 km		
Argument of Perigee	0°		
Active Service Arc	-90° to 90°[8]		
Right Ascension of the Ascending Node	30°	330°	0°
Initial Phase Angles	<10° between each satellite [9]		
Local Time of Descending Node	1:30 PM	10:00 AM	10:00 AM

C. Ground Segment and Operations

The Mission Operations Center for GHOSt will be located at OSK's headquarters in San Francisco, California and at Astro Digital's facility in Santa Clara, California. Consistent with OSK's National Oceanic and Atmospheric Administration ("NOAA") license, the GHOSt

[7] The GHOSt spacecraft will be integrated and launched in pairs on a SpaceX Falcon 9 Rideshare vehicle, which will transport multiple mission payloads simultaneously. The anticipated average altitude of the operational GHOSt spacecraft is 525 km in a circular SSO. *See* ODAR at 2; *see also* Schedule S.

[8] Although the GHOSt satellites are capable of transmitting throughout the entire orbit, a GHOSt satellite will only transmit when visible to one of its earth stations. *See* Technical Annex, §§ A.2.a. and A.7.

[9] Given that the satellites are launched two at a time from the same launch vehicle, the initial phase angles will be very small. Over time, the two satellites in a given plane will separate further within their respective orbital planes and eventually be separated by 180°. *See* Technical Annex, § A.2.a.

constellation will be monitored at all times via automated and human systems, facilitating rapid response to any technical or regulatory concerns.[10]

OSK will conduct its mission operations through a network of ground stations that will initially consist of facilities in (i) Santa Clara, California; (ii) Tromsø, Norway, (iii) Svalbard, Norway, and (iv) Troll, Antarctica.[11] OSK may expand its ground station network over the course of the operational lifetime of the GHOSt constellation to include additional commercial stations either within or outside the United States and will seek to modify its authorization as conditions arise. OSK has initiated coordination efforts with Federal operators in its requested bands and will operate in accordance with the terms of any agreements.[12]

D. Launch Schedule

The GHOSt satellites will be launched in pairs using a secondary payload launch service. OSK currently anticipates an initial launch of GHOSt-01 and GHOSt-02 in Q4 2022. Based on current projections, OSK anticipates deploying the entire GHOSt constellation by Q2 2023.[13]

III. SPECTRUM USE AND SHARING CAPABILITIES

The GHOSt constellation will operate in a manner that will not materially constrain co-frequency operators and will allow for spectrum sharing across all requested frequency bands because: (1) OSK has initiated coordination discussions with Federal operators in the requested spectrum bands and will operate in accordance with any applicable coordination conditions; (2)

[10] National Environmental Satellite Data and Information Service, NOAA Licensees (last visited Dec. 2, 2021), https://www.nesdis.noaa.gov/commercial-space/regulatory-affairs/licensing/noaa-licensees.

[11] *See* Technical Annex, § A.2.c.

[12] *See id.*, § A.7.c.

[13] *See* ODAR at 2.

the GHOSt satellites only transmit/receive while visible to the relevant earth stations, reducing the likelihood of interference to other systems and allowing for interference mitigation through coordination; (3) the GHOSt constellation uses earth stations located at very high latitudes (*e.g.*, Svalbard, Norway at 78°N), thus limiting the number of potential victim earth stations; (4) GHOSt transmissions have a small and directed beamwidth of only 7.4° for payload downlink transmissions; and (5) the power flux-density of all transmissions comply with the limits set by both the Commission and the International Telecommunication Union ("ITU"), further reducing the possibility of interference.[14] Accordingly, GHOSt operations will avoid harmful interference and not materially constrain current and future co-frequency spectrum users.

A. Ka-Band Payload Downlink

OSK seeks authorization to utilize the 25.5-27.0 GHz band for payload downlink operations under the co-primary EESS (space-to-Earth) allocation.[15] Like other EESS systems licensed pursuant to the Commission's rules,[16] the hyperspectral sensor carried by each GHOSt satellite will observe and record data relating to the characteristics of the Earth and its natural phenomena, and downlink such data to earth stations that are part of the satellite network.[17] All data transmitted in the requested band will be limited to payload sensor data or metadata directly pertaining to the operation of the payload.

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[14] *See* Section IV.A *infra*; *see also* Schedule S.

[15] *See* 47 C.F.R. § 2.106 n.US258.

[16] *See, e.g.*, *Application of Capella Space Corp. for Authority to Launch and Operate a Non-Geostationary Orbit Satellite System in the Earth Exploration Satellite Service*, Stamp Grant, File No. SAT-LOA-20210119-00012 (Granted May 4, 2021).

[17] *See* 47 C.F.R. § 2.1 ("Earth Exploration-Satellite Service. A radiocommunication service between earth stations and one or more space stations, which may include links between space stations, in which: (1) Information relating to the characteristics of the Earth and its natural phenomena, including data relating to the state of the environment, is obtained from active sensors or passive sensors on Earth satellites…").

As detailed more fully in the Technical Annex, the high gain Ka-band antennas employed by the GHOSt satellites will use six band channels, allowing for six wideband emissions to share three frequency channels using polarization diversity, thereby enabling the GHOSt satellites to utilize the requested spectrum at its highest efficiency.[18]

OSK will be able to facilitate sharing with existing and future operations in the 25.5-27.0 GHz band for the reasons identified above. Moreover, as few satellite operators utilize the band for EESS, the opportunity for harmful interference is limited and can be adequately mitigated, as needed, through the coordination process.

B. S-Band Adaptive Coding and Modulation and TT&C Uplink

OSK seeks authorization to utilize the 2025-2110 MHz band for telemetry, tracking, and command ("TT&C"), as well as modulation and coding of the high speed data ("HSD") link for payload transmissions. Specifically, OSK plans to use the 2045.0-2050.0 MHz band for the HSD control uplink. This technique adjusts the satellite's modulation and coding to optimize payload downlink conditions, ensure proper link performance and efficiency, and advise the spacecraft to retransmit any lost data frames. A second link, operating within the 2054.85-2055.15 MHz band, will provide the traditional TT&C uplink operations for the GHOSt satellites.[19]

Non-Federal Earth-to-space transmissions in the 2025-2110 MHz band may be authorized in the EESS services subject to such conditions as may be applied on a case-by-case basis. Uplink transmissions shall not cause harmful interference to authorized Federal and non-Federal

[18] In all cases, the power flux-density of these transmissions comply with the limits set by both the Commission and the ITU. *See* Technical Annex, § A.2.b; *see also* 47 C.F.R. § 25.208(p).

[19] Out of an abundance of caution, and to the extent necessary, OSK requests a waiver of 47 C.F.R. § 25.202(g)(1) to permit TT&C operations not at band edge. Good cause for waiver exists here as OSK's uplink operations are purely limited to TT&C and control operations. No service bands are requested for uplink operations from which a band edge may be derived.

operations operating in accordance with the Table of Frequency Allocations.[20] OSK has already initiated coordination with Federal operators in this band to ensure that OSK uplinks do not interfere with critical systems of these agencies,[21] and will coordinate with additional co-frequency operators, as necessary, to ensure spectrum sharing consistent with the Commission's rules.[22]

C. UHF TT&C Downlink

The GHOSt constellation will use the 400.15-401.0 MHz band for TT&C downlink telemetry operations consistent with the secondary allocation for the Space Operation service (space-to-Earth) and other smallsat operators authorized to operate in this band.[23] OSK will comply with all technical requirements and complete any necessary coordination with Federal operators to ensure spectrum sharing is successful.

D. L-Band Intersatellite Links

OSK plans to use a space-to-space link between its GHOSt satellites and the existing commercial Globalstar NGSO constellation. The GHOSt satellites will transmit to Globalstar

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[20] 47 C.F.R. § 2.106 n. US 347. The Commission has recently granted multiple EESS applications proposing TT&C uplink operations within this band. *See, e.g*, *Application of Capella Space Corp. for Authority to Launch and Operate a Non-Geostationary Satellite Orbit System in the Earth-Exploration Satellite Service*, Stamp Grant, File No. SAT-LOA-20200914-00108 (Dec. 17, 2020); *see also Amendment Application of Loft Orbital for Authority to Launch and Operate a Non-Geostationary Satellite Orbit System in the Earth-Exploration Satellite Service*, Stamp Grant, File No. SAT-AMD-20200527-00063 (Granted Oct. 8, 2020) ("Loft Orbital Grant").

[21] For example, OSK has already initiated coordination discussions with representatives from NASA regarding the planned operations of the GHOSt constellation within this spectrum band. *See* n.12 *supra*.

[22] *See* Technical Annex, § A.7.

[23] The Commission recently granted Astro Digital U.S., Inc.'s TT&C operations in the space-to-Earth direction within this same band. *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).

satellites, pursuant to an agreement with Globalstar, but will not have the capability to receive communications from the Globalstar satellites. These transmissions are approved and supported by Globalstar and fall within Globalstar's currently licensed spectrum. Globalstar will be responsible for obtaining its own authorizations, as necessary.[24]

IV. WAIVER REQUESTS

The Commission may waive any of its rules if there is "good cause" to do so.[25] In general, waiver is appropriate if (1) special circumstances warrant a deviation from the general rule; and (2) such deviation would better serve the public interest than would strict adherence to the rule.[26] Generally, the Commission will grant a waiver of its rules in a particular case if the relief requested would not undermine the policy objective of the rule in question and would otherwise serve the public interest.[27] OSK respectfully submits that good cause exists to waive the following Commission rules when granting the instant application.

A. Modified Processing Round Rules

OSK requests waiver of Sections 25.156 and 25.157 of the Commission's rules, which stipulate the processing of "NGSO-like satellite systems" under a modified processing round framework.[28] Instead, OSK requests that the Application be processed pursuant to the first-come, first-served procedure adopted for "GSO-like satellite systems" pursuant to Section 25.158.[29]

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[24] *See* ELS File No. 0225-EX-CN-2022.

[25] *See* 47 C.F.R. § 1.3; *Northeast Cellular Tel. Co. v. FCC*, 897 F.2d 1164 (D.C. Cir. 1990); *WAIT Radio v. FCC*, 418 F.2d 1153 (D.C. Cir. 1969).

[26] *See Northeast Cellular*, 897 F.2d at 1166.

[27] *See WAIT Radio*, 418 F.2d at 1157.

[28] 47 C.F.R. §§ 25.156, 25.157.

[29] 47 C.F.R. § 25.158.

Such a waiver would be consistent with Commission precedent and should be granted in this instance.[30]

Since the GHOSt constellation and satellites in other similar systems only transmit/receive for short periods of time while in view of a relevant earth station, spectrum sharing is possible. Transmissions to and from earth stations can be coordinated among EESS operators to avoid any potential, albeit unlikely, in-line interference events. As a result, the instant application will not create mutual exclusivity with other NGSO EESS systems in the same frequency bands nor will it preclude future entry. Therefore, good cause exists to waive the modified processing rules here consistent with precedent.

B. Default Service Rules

OSK requests a waiver of the default service rules pursuant to Section 25.217(b) of the Commission's rules.[31] The Commission has previously granted a waiver of the default service rules to NGSO EESS applicants since operators are required to comply with technical requirements in Part 2 of the Commission's rules and applicable ITU rules.[32] As a result, the Commission concluded that the requirements were sufficient to prevent harmful interference and there was no need to impose additional technical requirements. The same rationale applies to the instant

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[30] *See*, *e.g.*, Stamp Grant, Planet Labs, Inc., IBFS File No. SAT-LOA-20130626-00087 (granted Dec. 3, 2013) ("Planet Labs Stamp Grant"); Stamp Grant, Skybox Imaging, Inc., IBFS File No. SATLOA-20120322-00058 (granted Sept. 9, 2012) ("Skybox Imaging Stamp Grant"); *Space Imaging, LLC*, Declaratory Order and Order and Authorization, 20 FCC Rcd 11964 ¶¶ 9-11 (2005) ("Space Imaging Order").

[31] 47 C.F.R. § 25.217(b).

[32] *See* Space Imaging Order ¶¶ 26-31; *DigitalGlobe, Inc*., Order and Authorization, 20 FCC Rcd 15696 ¶¶ 1, 15 (2005); *see also* Planet Labs Stamp Grant; Skybox Imaging Stamp Grant; Stamp Grant, Spire Global Inc., IBFS File No. SAT-LOA-20151123-00078 (granted in part Mar. 18, 2016).

application. Accordingly, good cause exists for the Commission to grant waiver of the default service rules.

C. U.S. Table of Frequency Allocations - 1615-1617.5 MHz (space-to-space) Inter-Satellite Service Links (Globalstar Frequencies)

OSK requests a waiver of the U.S. Table of Frequency Allocations to use specific Globalstar frequencies for space-to-space inter-satellite data relay service ("IDRS").[33] The GHOSt satellites will use a conventional (but, space-hardened) NSL Eyestar-S3 Simplex radio (FCC type-approved) as the IDRS modem. The IDRS modem will operate on Globalstar-authorized and assigned channels centered at 1616.25 MHz.[34] The 1615-1617. 5 MHz sub-band is allocated to Mobile Satellite Service (Earth-to-space) on a primary basis, and the Commission has previously authorized Globalstar to communicate with U.S.-licensed earth stations in this band.[35]

As discussed in more detail in the Technical Annex, use of these frequencies for IDRS will allow for spectrum sharing and will not cause harmful interference to other authorized operations. Given a top end emission of 1617.5 MHz, OSK's IDRS operations will not overlap with the lower portion of the shared Iridium-Globalstar spectrum band.[36] Moreover, the IDRS modem will only be used in limited, time-sensitive scenarios as part of OSK's service offerings to its customers. OSK anticipates primarily using the IDRS modem to send alerts based on analytics from one or

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[33] *See* 47 C.F.R. §§ 2.102(a), 2.106. The band is also authorized for Mobile Satellite Service (space-to-Earth) transmissions on a secondary basis.

[34] The Commission has recently granted waiver requests to operate an IDRS in similar spectrum bands using the Globalstar system. *See, e.g.*, Loft Orbital Grant at Condition 9.

[35] *See*, *e.g.*, *Policy Branch Information, Actions Taken*, Report No. SAT-01042, File No. SAT-MOD-20130314-00030 (Sept. 19, 2014) (Public Notice).

[36] OSK notes that Iridium's service links are in the 1617.775-1626.5 MHz part of the Big LEO band. OSK confirms that it will not operate in this part of the L-band.

more of the GHOSt satellites. This capability serves the public interest by greatly increasing the responsiveness of the GHOSt system, improving safety, and potentially saving lives in emergency situations. For these reasons, OSK respectfully requests that the Commission grant a waiver of the U.S. Table of Frequency Allocations to permit the GHOSt constellation to communicate with Globalstar satellites.

V. GRANT OF THE APPLICATION IS IN THE PUBLIC INTEREST

The grant of the instant application will serve the public interest by facilitating the near-term deployment of enhanced hyperspectral monitoring capabilities for commercial, scientific, and government applications. Upon deployment, the GHOSt constellation satellites will produce the highest resolution commercial hyperspectral imagery launched to-date. The market-leading sensing capabilities provided by OSK enable customers in the energy, extraction, infrastructure, agriculture, and forestry industries to make vital decisions with better information, thereby improving safety and potentially saving lives. The following are just some of the key industry sectors that will benefit from capabilities unlocked by the GHOSt constellation:

***National Defense*:** GHOSt's hyperspectral sensors can capture critical environmental and situational awareness information for use in national defense and crisis response efforts, including plume, camouflage, chemical weapon signatures, and target detection. In October 2020, the United States Department of the Air Force's commercial investment group, in conjunction with the Space and Missile Systems Center, and the Air Force Research Laboratory, contracted with OSK to accelerate the deployment of these services.[37] Upon deployment, OSK plans to integrate

[37] *See*, *e.g.*, Press Release, *Orbital Sidekick Awarded $16M U.S. Air Force STRATFI Contract*, ORBITAL SIDEKICK, INC. (Oct. 15, 2020), https://orbitalsidekick.com/orbital-sidekick-awarded-16m-u-s-air-force-stratfi-contract/.

GHOSt's monitoring services with the United States Air Force Advanced Battle Management System.

Infrastructure Monitoring. GHOSt's hyperspectral imaging can detect minute changes in physical infrastructure and report such changes in real-time, allowing operators to monitor the integrity of their mission-critical infrastructure more closely and maintain infrastructure more cost-effectively. GHOSt is particularly well suited for monitoring energy infrastructure, such as oil and gas pipelines, and for ensuring regulatory compliance, such as leak prevention and early leak detection.

***Environmental and Agricultural Monitoring*:** GHOSt will enable customers to collect and access vital data on environmental erosion and degradation, including the evapotranspiration levels for crops. These data sets provide OSK customers with early-warning detection of water, air, and land pollution, as well crop viability and yield.

Taken together, the GHOSt constellation will provide valuable new services for customers in the United States and around the world. Critically, the GHOSt constellation will provide these services while becoming neither a potential new source of orbital debris nor a source of harmful interference to co-frequency operators. For these reasons, OSK submits that grant of this application is in the public interest.

VI. OTHER MATTERS

A. NOAA Authorization

OSK was issued a license to operate a private remote sensing space system by NOAA's National Environmental Satellite, Data, and Information Service on September 3, 2021. The NOAA license permits OSK to operate the private remote sensing constellation of up to 6 hyperspectral imaging satellites, subject to the conditions and terms of the license. The NOAA license includes findings that OSK satisfies the requirements for compliance and monitoring, will

comply with the national security concerns of the United States, and will comply with all applicable international obligations and foreign policies.

B. ITU Compliance

OSK acknowledges that pursuant to Section 25.111 of the Commission's rules, the Commission will submit filings to the ITU on OSK's behalf and that OSK is responsible for any and all fees charged by the ITU for such filings.[38] OSK has provided the Commission with the appropriate electronic files for submission to the ITU. A copy of OSK's ITU Cost Recovery Letter is attached to this application.[39]

VII. CONCLUSION

For the foregoing reasons, and for the reasons set forth in the accompanying materials, OSK respectfully requests the Commission determine that granting OSK operating authority for the GHOSt constellation proposed herein would serve the public interest, and issue such grant expeditiously.

Respectfully submitted,

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[38] 47 C.F.R. § 25.111.

[39] Attachment D, ITU Cost Recovery Letter.