Satellite Industry Association: Remote Sensing Spectrum White Paper

The Satellite Industry Association (SIA) is a U.S.-based trade association representing the leading satellite operators, manufacturers, launch providers, and ground equipment suppliers who serve commercial, civil, and military markets.[1] Since its creation almost twenty years ago, SIA has been the unified voice of the U.S. satellite industry on policy, regulatory, and legislative issues affecting the satellite business. SIA represents the satellite remote sensing industry, and has developed the remote sensing spectrum whitepaper below.

Abstract

U.S. companies are developing innovative uses for small satellites, primarily related to Earth observation and sensing services. These innovations will allow the private sector to augment, and potentially replace, certain capabilities of the U.S. civil and defense space agencies (public/private partnerships).[2] *In this paper, small satellites are defined as those with a mass of less than 180 kg and include those as small as 1 kg.*

Space science spectrum allocations are predominantly Federal only uses. As a result, innovative smallsat companies must coordinate spectrum access with the U.S. Federal spectrum users, prior to obtaining an FCC license, rather than after securing an FCC license. SIA recognizes and appreciates the efforts of Federal spectrum managers to work with smallsat companies in coordination efforts. SIA, however, notes that there are challenges. For example, Federal agencies have been extremely hesitant to allow non-Federal small sat operators to share frequency bands with them. In cases where a license is obtained, the existing process requires many months, if not years, to finalize coordination where U.S. Federal agencies retain significant discretionary authority. In other jurisdictions such as Luxembourg, where admittedly space science programs are less developed, a license grant can take around 3-6 months, a timeline that is becoming more common in other similarly-situated jurisdictions. Innovative smallsat companies rely predominantly on venture investing. Inability to obtain or undue delay in

[1] SIA Executive Members include: AT&T Services, Inc.; The Boeing Company; EchoStar Corporation; Intelsat S.A.; Iridium Communications Inc.; Kratos Defense & Security Solutions; Kuiper Systems LLC; Ligado Networks; Lockheed Martin Corporation; OneWeb; SES Americom, Inc.; Space Exploration Technologies Corp.; Spire Global Inc.; and Viasat, Inc. SIA Associate Members include: ABS US Corp.; Airbus Defense and Space, Inc.; Analytical Graphics, Inc.; Artel, LLC; Blue Origin; Eutelsat America Corp.; ExoAnalytic Solutions; Globalstar, Inc.; Glowlink Communications Technology, Inc.; HawkEye 360; Hughes; Inmarsat, Inc.; Kymeta Corporation; Leonardo DRS; Omnispace; Panasonic Avionics Corporation; Peraton; Planet; Speedcast Government; SSL; Telesat Canada; and XTAR, LLC. For more information, visit www.sia.org.

[2] National Aeronautics and Space Administration ("NASA"), Department of Defense ("DOD"), National Geospatial-Intelligence Agency ("NGA"), National Oceanic and Atmospheric Administration ("NOAA"), and other U.S. Federal agencies are utilizing new satellite technologies and capabilities (either internally developed or acquired from the private sector) to meet existing government needs. *See, e.g.*, Steve Fetter and Tom Kalil, *Harnessing the Small Satellite Revolution*, WhiteHouse.Gov Blog (October 21, 2016), https://www.whitehouse.gov/blog/2016/10/21/harnessing-small-satellite-revolution (noting a $20 million award by NGA to Planet Labs Inc. ("Planet") and $30 million commitment by NASA to small satellite programs); *Commercial Weather Data Pilot (CWDP)*, Department of Commerce, http://www.space.commerce.gov/business-with-noaa/commercial-weather-data-pilot-cwdp/ (last viewed Mar. 31, 2017) (stating that GeoOptics and Spire Global, Inc. ("Spire") won awards with NOAA to provide space-based global navigation satellite system ("GNSS") radio occultation data for the purpose of demonstrating data quality and potential value to NOAA's weather forecasts and warnings).

obtaining a license threatens funding stream for smallsat companies. Furthermore, while the SIA recognizes the importance of protecting needed spectrum for critical government space science services, the imposition of technical operating conditions that focus only on protection of those services may fail to account for commercial operations and business needs. As a result, the growth of the U.S. smallsat industry may be stunted and U.S. companies may be forced to move offshore to take advantage of more expedient licensing jurisdictions.

SIA and its smallsat member companies believe that either (i) a small amount of spectrum should be designated as a "sharing sandbox" or "exclusive commercial zone" to allow smallsat companies to flourish in the U.S. so that the U.S. can build upon the critical capabilities provided by small satellites and/or (ii) the coordination process should be altered in bands shared between commercial and Federal earth observation or remote sensing users to provide an accelerated and more predictable process.

This Whitepaper reviews the current availability of spectrum in the U.S. (versus international allocations), the needs of U.S. smallsat companies, the consequences of the lack of spectrum, and suggested corrective actions.

I. Spectrum Available to Smallsat Companies

The chart ("Smallsat Spectrum Chart") below highlights (i) the various bands allocated internationally to a smallsat company's service classes (Non-Voice, Non-Geostationary Mobile-Satellite Service; Space Operations Service ("SpaceOps"); Earth-Exploration-Satellite Service; and Meteorological-Satellite Service)[3] and (ii) the dearth of bands available domestically. It is important to note that the commercial smallsat operators do not have access to adequate spectrum because most of the International Telecommunication Union ("ITU") allocations are implemented for U.S. Federal space sciences, and the remaining spectrum available for commercial use is shared with Federal services. This spectrum is restricted by U.S. Federal agencies for the reasons set out below.

Available in United States (red indicates Federal allocations)

Possible Smallsat Spectrum Based on ITU Allocations	ITU Allocation	Use Case	Limitations for U.S. commercial smallsat use
235-322 MHz (87 MHz) / 335.4-399.9 MHz (64.5 MHz)	(secondary) Space-Operation Downlink	Omnidirectional Tracking, Telemetry & Control Downlink	There are DoD systems of unknown location, type, and use. No commercial access
272-273 MHz (1 MHz)	(secondary) Space-Operation Downlink	Downlink	There are DoD systems of unknown location, type, and use. No commercial access

[3] *See generally* 47 C.F.R. § 25.103 (stating definitions for various satellite services).

399.9-400.05 MHz (150 kHz)	(primary) Space-Operation Uplink	Omnidirectional Tracking, Telemetry & Control Uplink	NTIA petitioned to have this band shared with Federal. Will be used for NOAA CDARS system
401-402 MHz (1 MHz)	(primary) Space-Operation Downlink	Omnidirectional Tracking, Telemetry & Control Downlink	Being restricted for National Weather Service radiosondes and NOAA GEO DCPs
402-403 MHz (1 MHz) NINP by footnote)	(primary) EESS Downlink	Omnidirectional Tracking, Telemetry & Control Uplink	Being restricted for National Weather Service radiosondes and NOAA GEO DCPs
449.75-450.25 MHz (.50 MHz)	(secondary by footnote) Uplink	Omnidirectional Tracking, Telemetry & Control Uplink	No allocation issue is identified; however, the band is subject to mandatory, time-consuming ITU coordination and is very congested in parts of the world
2025-2110 MHz (85 MHz) (NINP by footnote)	(primary) Space-Operation EESS Uplink	High Capacity Uplink	Coordination with the thousands of Fixed Service and Mobile Service licensees in the band can be time-consuming and costly
2200-2290 MHz (90 MHz)	(primary) Space-Operation EESS Downlink	High Capacity Downlink	NASA/NOAA/DoD systems are primary concern
8025-8400 MHz (375 MHz)	(primary) EESS Downlink	High Capacity Downlink	NASA systems in “polar regions” require close coordination, but it is possible
25.5-27 GHz (1.5 GHz)	(primary) EESS Downlink	High Capacity Downlink	It is an emerging band of interest for small satellites as the technology cost is decreasing and available ground stations services improve

More detail about why U.S. Federal agencies are restricting access to the 399.9-400.05 MHz, 401-402 MHz, 402-403 MHz, and 2200-2290 MHz bands is set out below.

399.9-400.05 MHz. The 399.9-400.05 MHz band was one of the few bands allocated only to non-Federal users on a primary basis. However, NOAA, through the National Telecommunications and Information Administration (“NTIA”), recently petitioned the FCC to move this to a “shared band” between Federal and non-Federal. The FCC never acted on the petition; however, NTIA informed a smallsat company that it could not use the band as an uplink because of NOAA’s one Cooperative Data and Rescue Services

("CDARS") satellite, which has a launch ready date of 2020,[4] effectively cordoning off what was previously exclusive non-Federal spectrum for a single future Federal satellite.[5]

401-402 MHz. The 401-402 MHz band is allocated to SpaceOps for non-Federal users and various Federal users on a co-primary shared basis. However, NOAA has expressed interference concerns with National Environmental Satellite, Data, and Information Service ("NESDIS") Geostationary Operational Environmental Satellite ("GOES") satellite Data Collection Platforms ("DCPs")[6] and National Weather Service's ("NWS") radiosondes[7] in the lower ultra high frequency ("UHF") band. NWS is transitioning parts of its radiosonde program into 400.15-406 MHz from L-band with the final frequencies to be determined at a later date. As of today, nineteen (19) radiosondes operate in 402-403 MHz in the U.S., twice per day (usually at the same time), every day, from the same location, for approximately 1.5 hours at a time. Informal conversations with NWS indicate radiosondes will likely fully transition in a decade, to a total of 92, in addition to roughly 100 radiosonde sites used by other government agencies (including the Department of Energy, several Navy and Air Force bases, and the launch ranges at Wallops Island, Kodiak, Cape Canaveral, and Vandenberg). Due to the predictability of these devices, interference mitigations such as blackout periods or geographic restrictions could open up these bands for additional use. Nonetheless, NWS is effectively restricting the entire range for its own future use and has told commercial companies to vacate the band.[8]

402-403 MHz. This band is allocated in the ITU table and available as an uplink to non-U.S. companies; however, it is not allocated beyond Federal use in the U.S.[9]

2200-2290 MHz. Various NASA, DOD, and NOAA operations[10] are protected in the S-band 2200-2290 MHz downlink within the U.S. . The 2200-2290 MHz band is used extensively by non-U.S. operators for commercial missions. Any use of this band outside the U.S. by a U.S. operator is subject to a lengthy ground-station-by-ground-station coordination analysis by the Federal agencies, whereas such use by non-U.S. companies is straightforward.

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[4] *See NOAA Satellite Plans*, NOAA at 14 (Mar. 16, 2016), http://www.ofcm.gov/meetings/TCORF/ihc16/Presentations/Panel%202/02-IHC-NESDIS-Overview-no-backups.pdf

[5] A number of SIA Earth Observation Forum ("EOF") members report applications in this band that have been indefinitely deferred.

[6] *See GOES Data Collection System*, NOAA, http://www.noaasis.noaa.gov/DCS/ (last updated Apr. 18, 2017).

[7] *See NOAA National Weather Service Radiosonde Observations*, NOAA, http://www.ua.nws.noaa.gov/factsheet.htm (last viewed Apr. 27, 2017).

[8] SIA EOF members report there are a several FCC license grants directing operators to transition out of 401-406 MHz because of radiosondes relocating there.

[9] There are secondary EESS/MetSat allocations available in the U.S. Elsewhere in the world, there are primary EESS/MetSat allocations available.

[10] *See, e.g.*, Ashley Campbell, *Tracking and Data Relay Satellite (TDRS)*, NASA (Feb. 24, 2017), https://www.nasa.gov/directorates/heo/scan/services/networks/txt_tdrs.html ("The current Tracking and Data Relay Satellite configuration consists of nine in-orbit satellites (four first generation, three second generation and two third generation satellites) distributed to provide near continuous information relay service to missions like: The Hubble Space Telescope (HST) The International Space Station (ISS)."); *Space Ground Link Subsystem Ground Station System Analysis*, Philco-Ford Corporation (Nov. 15, 1968), http://www.dtic.mil/dtic/tr/fulltext/u2/853122.pdf ("The Space-Ground Link Subsystem (SGLS) [is] the major subsystem to be used as a prime source of tracking, telemetry data, and command and control capability in support-of all satellite programs that are serviced by the Air Force Satellite Control Facility (AFSCF)."); *NOAA's Geostationary and Polar-Orbiting Weather Satellites*, NOAA, http://noaasis.noaa.gov/NOAASIS/ml/genlsatl.html (last updated Mar. 5, 2014) ("The polar orbiters are able to monitor the entire Earth, tracking atmospheric variables and providing atmospheric data and cloud images.").

8025-8400 MHz. NASA has expressed concern with smallsat operations in the X-band (8025-8400 MHz) particularly higher than 45 degrees latitude because of concerns with the Landsat Program.[11] NASA has been more willing to work with smallsat operators than other agencies, and thus, that frequency band remains available . However, this coordination process can take over a year and often limits smallsat operations above 45 degrees latitude (which is critical for satellites in a polar orbit). It should be noted that NOAA uses a portion of this band above 8200 MHz for raw data downlink of GOES-R-series satellites, the S-NPP satellite, and the JPSS series.

25.5 – 27 GHz. This band is readily available for FCC licensing. Some smallsat operators are beginning to use this band due to increased data downlink bandwidth requirements and wanting to avoid X-band congestion. However, the available ground system infrastructure for Ka-band is limited and remains more expensive and challenging to implement on spacecraft.

II. Smallsat Company Spectrum Needs

A) Smallsat companies need an omnidirectional link in UHF-band to checkout and stabilize their satellites.

Smallsat companies need an omnidirectional link to checkout and stabilize their satellites; this omnidirectional link is currently only practicable in the UHF band. For example, at least five smallsat companies have sought to use 401-402 MHz (space-to-Earth), which is the only downlink (allocated to non-Federal users in the U.S.) suitable for these purposes. As seen in the Smallsat Spectrum Chart above, there is no additional downlink allocation in UHF for this use other than 401-402 MHz. For the UHF uplink, 399.9-400.05 MHz (Earth-to-space) is being restricted for a planned single NOAA satellite, CDARS, so there is currently only one viable uplink, 449.75-450.25 MHz (Earth-to-space), which is subject to mandatory, time-consuming ITU coordination and has proven to be highly congested in parts of the world.

Notably, Federal systems do not use the entirety of the allocated UHF bands in question. DCP transmissions in GOES N-P, GOES-R, and GOES-Next Series systems utilize 401.7-402.4 MHz. Similarly, the largest channel of CDARS/ARGOS will utilize channels as large as 6.62 kHz within 399.9-400.05 MHz.[12] Additionally, footnote US319 in the Table of Spectrum Allocations restricts bands 399.9-400.05 MHz and 400.15-401 MHz use to Federal MSS earth stations operating with non-Federal space stations.[13]

Smallsat companies need somewhere between 60-200 kHz of bandwidth in these UHF bands.

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[11] *See Landsat Science*, NASA, https://landsat.gsfc.nasa.gov/ (last updated May 1, 2017) ("This joint NASA/USGS program provides the longest continuous space-based record of Earth's land in existence.").

[12] "NOAA Use of Frequency Bands: Current and Future", NOAA, Presentation to CGMS-45 Working Group 1 session, agenda item 3, June 2017 http://www.wmo.int/pages/prog/sat/meetings/IPT-SWeISS-1/documents/6.1.5_CGMS-45-NOAA-WP-04_PPT.pdf

[13] "FCC Online Table of Frequency Allocations", 47 C.F.R. § 2.106, May 7, 2019 https://transition.fcc.gov/oet/spectrum/table/fcctable.pdf

B) Smallsat companies also need a directional, high-capacity downlink for downloading data and for uploading data and software. Both operations are possible using S-band and X-band frequencies.

Smallsat companies have applied for anywhere from 1 MHz to 5 MHz in S-band (2200-2290 MHz and 2025-2110 MHz) and 60 MHz to 300 MHz in X-band (8025-8400 MHz).[14] Applications for Ka-band (25.5 – 27 GHz) are emerging.[15]

IV. Consequences to Smallsat Companies

Impact of the application and coordination process

It is the experience of SIA smallsat operators that the FCC, NTIA, and other agencies act in good faith to address pending smallsat license applications. Unfortunately, there are several systemic challenges that create unnecessary delays and introduce uncertainty in the process. For example, the FCC's Part 5 and Part 25 license process does not provide sufficient insight into the status of an application or what party is responsible for adjudicating next steps. Furthermore, SIA EOF members report license applications are subject to lengthy review periods while the FCC and NTIA finalize coordination.

SIA smallsat operators also report that agency staff responsible for conducting technical analysis and recommending license conditions to the NTIA are often understaffed, juggling competing priorities, including critical real-time satellite operations and numerous other spectrum coordination responsibilities. Consequently, smallsat companies face regulatory uncertainty and substantial financial harm, including multi-million dollar losses on booked launches. The coordination process is costly for both Federal and non-Federal users, with companies spending valuable capital on external lawyers and consultants to navigate the coordination system and address complexities in the process.

Impact of existing spectrum allocation

For the bands identified in this white paper, the major issue is the lack of dedicated spectrum for non-Federal smallsats. This lack of either a "sharing sandbox" or "exclusive non-federal zone" makes smallsat operators beholden to a complex coordination process with Federal users in dedicated Federal bands. In light of the significant growth of smallsats and anticipated increasing numbers of requests to operate in Federal bands, continuing without dedicated spectrum will only serve to raise the regulatory hurdles in an already challenging coordination process.

V. Proposed Corrective Measures

#1: **Fund more Full-Time Equivalent ("FTE") Employees:** SIA urges the Administration to fund additional FTEs at key civil agencies (e.g. NASA, NOAA) dedicated solely to supporting technical analysis and coordination with FCC Part 5 and Part 25 space system applicants in advance of NTIA's determination of operational conditions. As long as smallsat operators do not have dedicated spectrum, complex technical coordination efforts with Federal users is required. One benefit of providing dedicated

[14] *See* Application of Terra Bella Technologies Inc., IBFS File No. SAT-MOD-20150408-00019 (granted Aug. 31, 2016); Application of Terra Bella Technologies Inc., IBFS File No. SAT-MOD-20170713-00103 (granted July 19, 2018).
[15] See Application of Astro Digital US, Inc., IBFS File No. SAT-LOA-20170508-00071 (granted in part and deferred in part Aug. 1, 2018).

spectrum would be the cost savings from eliminating the need to hire additional Federal personnel to address smallsat coordination matters.

#2: **Improve the IT/filing system:** The FCC and NTIA should update their IT and filing system infrastructure to provide greater trackability, transparency, and accountability of license applications.

#3: **Impose Fixed Timelines:** All license applications should be treated equallyand have fixed timelines for the adjudication of an FCC license application once NTIA coordination is completed. For example, coordination of frequencies with the NTIA at the start of a commercial satellite application process (e.g., within 60 days of receipt of such application) could be required, and the NTIA could be required to respond to a coordination request with an approval or rejection within 30 days of its receipt of the FCC's coordination request. Or, direct coordination between the applicant and the incumbent federal agency user could be incorporated into the FCC regulations using the same timelines. Rejections should be accompanied by an interference analysis based on ITU protection criteria. Appropriate timelines, such as 30 days, should be included for the commercial operator to respond. Should agreement not be reached between the Federal agency rejecting the request and the commercial operator within a subsequent period of 30 days of the commercial operator's response, an independent review, consisting of FCC and NTIA representatives, should be established to conclude the matter within a final 60-day period. Such a process as outlined here would limit the decision period to 210 days.

#4: **Create a Spectrum Sandbox:** Create a spectrum sharing sandbox where some portion of the spectrum is made available for explicit sharing between like systems and services.

#5: **Allocate Federal-Only Spectrum for Exclusive Non-Federal Use:** As an alternative to (or complementary to) a spectrum sharing sandbox, a small portion of spectrum could be allocated exclusively to the non-Federal (commercial) side of the U.S. Table of Frequency Allocations such that coordination with Federal agencies would not be required for such bands.