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

In the Matter of	)	
	)	
Single Network Future: Supplemental Coverage from Space	)	GN Docket No. 23-65
	)	
	)	
Space Innovation	)	IB Docket No. 22-271

**COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES**

The National Academy of Sciences, through its Committee on Radio Frequencies (hereinafter, CORF[1]), hereby submits its comments in response to the Commission's Further Notice of Proposed Rulemaking ("*FNPRM*"), FCC 24-28,[2] released March 15, 2024, in the above-captioned dockets. It is commendable that the Commission is seeking ways to protect vulnerable radio astronomy observations from satellite transmissions under the new Supplemental Coverage from Space ("SCS") rules. In these Comments, CORF discusses the need for such protection and specific measures to protect bands allocated to the Radio Astronomy Service ("RAS"). Because SCS will introduce significant and fundamental changes in the radio frequency interference ("RFI") environment necessary to critical RAS research, CORF recommends the adoption of specific protections for RAS, including those proposed in the National Science Foundation ("NSF") white paper "A Preliminary Assessment of Potential

---

1 See the Appendix for the membership of the Committee on Radio Frequencies.
2 Federal Communications Commission (FCC), 2022, "Single Network Future: Supplemental Coverage from Space," FNPRM, FCC-24-28, March 15, 2024.

Impacts to Radio Astronomy Systems from Supplementary Coverage from Space"[3] ("*NSF White Paper*"), which was recently filed in this proceeding.

I. The Importance and Vulnerability of Radio Astronomy, and the Likely Impact of SCS on RAS.

As the Commission has long recognized, radio astronomy is a vitally important tool used by scientists to study the universe. It was through the use of radio astronomy that scientists discovered the first planets outside our solar system, circling a distant pulsar. The Nobel Prize–winning discovery of pulsars by radio astronomers has led to the recognition of a widespread population of rapidly spinning neutron stars with surface gravitational fields up to 100 billion times stronger than that on Earth. Subsequent radio observations of pulsars have revolutionized understanding of the physics of neutron stars and have resulted in the first experimental evidence for gravitational radiation, which was recognized with the awarding of another Nobel Prize. Radio astronomy measurements also led to the Nobel Prize–winning discovery of the cosmic microwave background, the radiation left over from the Big Bang, which has defined a whole new field of cosmology. Radio astronomy has enabled the discovery of organic matter and prebiotic molecules outside our solar system, leading to new insights into the potential existence of life elsewhere in the Milky Way Galaxy. Radio spectroscopy and broadband continuum observations have identified and characterized the birth sites of stars in the Milky Way, the processes by which stars slowly die, and the complex distribution and evolution of galaxies in the universe. The enormous energies contained

---

[3] National Science Foundation, 2024, "A Preliminary Assessment of Potential Impacts to Radio Astronomy Systems from Supplementary Coverage from Space," white paper, submitted in FCC Docket 23-65 by the National Telecommunications and Information Administration, February 16, 2024 ("*NSF White Paper*").

in the enigmatic quasars and radio galaxies discovered by radio astronomers have led to the recognition that most galaxies, including our own Milky Way, contain supermassive black holes at their centers, a phenomenon that appears to be crucial to the creation and evolution of galaxies. Indeed, the only images of super massive black holes and their shadows, in the center of the M87 galaxy[4] and in the Milky Way galaxy,[5] were obtained by an array of radio telescopes. Synchronized observations using widely spaced radio telescopes around the world give extraordinarily high angular resolution, far superior to that which can be obtained using the largest optical telescopes on the ground or in space.

The critical scientific research undertaken by RAS observers, however, cannot be performed without access to interference-free spectral bands and protected, or heretofore remote, geographic locations. Notably, the emissions that radio astronomers receive are extremely weak—a radio telescope receives less than 1 percent of one-billionth of one-billionth of a watt (10^{-20} W) from a typical cosmic object. Because radio astronomy receivers are designed to pick up such remarkably weak signals, radio observatories are particularly vulnerable to interference from in-band emissions, spurious emissions, and out-of-band emissions ("OOBEs") from both licensed and

---

4 *See* The Event Horizon Collaboration, 2019, *Astrophysical Journal Letters* 875:L1. https://doi.org/10.3847/2041-8213/ab0ec7. *See also* J. Greene, 2019, "The Black Hole Photo Was No Big Surprise to Scientists. Here's Why It's Still a Big Deal," Opinion, *Washington Post*, April 12, https://www.washingtonpost.com/opinions/2019/04/12/black-hole-photo-was-no-big-surprise-scientists-heres-why-its-still-big-deal/; S. Kaplan and J. Achenbach, 2019, "See a Black Hole for the First Time in a Historic Image from the Event Horizon Telescope," April 10, https://www.washingtonpost.com/science/2019/04/10/see-black-hole-first-time-images-event-horizon-telescope; and D. Overbye, 2019, "Darkness Visible, Finally: Astronomers Capture First Ever Image of a Black Hole," *New York Times*, April 10, https://www.nytimes.com/2019/04/10/science/black-hole-picture.html.

5 *See* The Event Horizon Collaboration, 2022, *Astrophysical Journal Letters* 930:L2. https://doi.org/10.3847/2041-8213/ac6674.

unlicensed users of neighboring bands and from emissions that produce harmonic signals in the RAS bands, even if those human-made emissions are weak and distant.

As stated in Footnote US342, "emissions from spaceborne or airborne stations can be particularly serious sources of interference to the radio astronomy service." This applies even more so to the large constellations of low Earth orbit ("LEO") non-geosynchronous orbit ("NGSO") satellites recently approved by the Commission, as well as those to come. For example, current regulatory protection of radio quiet zones is not designed to address satellite transmissions, and the de facto protection once enjoyed by observatories in remote locations can no longer be assured. A recent U.S. Government Accountability Office ("GAO") technology assessment noted that:

> Transmission effects from satellites are not a new problem for radio astronomy, and astronomers have been able to mitigate those effects to some degree. However, as the number of satellites in LEO increases significantly, satellite transmissions may increasingly challenge radio astronomy's ability to detect faint cosmic signals. … As the number of satellites rapidly increases in LEO, there is an increased probability that there could be a satellite in the path of a radio telescope antenna no matter where it points in the sky. [6]

The concern of government agencies regarding the growing negative impact of satellite services on RAS is not limited to the GAO, and the risk is increased by the new SCS regulatory regime. In a filing recently made in this proceeding, NSF stated that:

> NSF's preliminary analysis indicates significant impacts to radio astronomy systems should SCS applications in terrestrial mobile allocations be implemented, due to the power levels and ubiquitous visibility in the sky. The proposed frequency bands are currently utilized by terrestrial cellular networks without the same level of harm to radio astronomy facilities as there are sources of attenuation including topography. By contrast, with SCS, direct boresight (down the main beam of radio astronomy receivers) encounters may even damage radio astronomy hardware. While it is possible that the severity of the harm to radio astronomy may be mitigated with careful coordination and selection of the absolute minimum bandwidths and power

---

[6] U.S. Government Accountability Office, 2022, *Large Constellations of Satellites: Mitigating Environmental and Other Effects*, https://www.gao.gov/products/gao-22-105166, at Section 3.3.1.

levels necessary for any permitted SCS, radio astronomy will be negatively impacted in any implementation scenario.[7]

In Comments filed in this proceeding on May 12, 2023, CORF considered two kinds of impact that SCS would have on radio astronomy and cited examples of the science that would be affected. The first impact involves RAS observations taking place in bands where RAS has a primary or secondary allocation. Here, the concerns are OOBE and spurious (especially harmonic) emissions associated with the SCS bands. In those earlier comments, CORF emphasized the need to minimize OOBE into the 608-614 MHz band (TV Channel 37), where RAS has a co-primary allocation, and to avoid second harmonic emission into the critical 1400-1427 MHz RAS primary allocation. The appropriate thresholds would be those set forth in Recommendation ITU-R RA.769-2. The recent *NSF White Paper* (at page 15) recognizes these concerns as well and identifies additional RAS primary or secondary bands for which there are harmonic emission concerns, including harmonics at 1610.6-1613.8 MHz, 1660-1670 MHz, and 1718.8-1722.2 MHz, where RAS has a co-primary allocation in the first two instances, and protection pursuant to International Footnote 5.149 in the third. CORF concurs with NSF's findings.

The second impact noted in CORF's earlier filing was to wide-band RAS observing that takes advantage of remote location and coordination with nearby active spectrum users to opportunistically observe at frequencies where RAS does not have a protected allocation. This includes the National Radio Quiet Zone ("NRQZ") and a handful of sites with de facto protection achieved through terrain shielding and location in unpopulated areas. The danger posed by SCS in this case is that whereas emissions

[7] *NSF White Paper*, at page 3.

from distant terrestrial networks are readily shielded by Earth curvature or terrain, this will not be the case for the thousands of transmitters in orbit that will support SCS, making coordination essential. Moreover, the frequencies allocated to these networks are of primary importance to a new generation of wide-band RAS observatories. The most advanced of these facilities—powered by the same performance advances and cost reductions in signal processing and computing technology that are driving the telecommunications revolution—not only employ wide bandwidths but also deploy large arrays of numerous wide-beamwidth elements, coherently combined to accomplish continuous wide-field mapping of the sky. This technology enables deep surveys across cosmic time and detection of transient events to which narrowly pointed telescopes are essentially blind. The *NSF White Paper's* comprehensive summary of existing and currently planned facilities and their respective observing bands includes references to several such facilities including the Allen Telescope Array,[8] the Deep Synoptic Array-2000,[9] and the Canadian Hydrogen Intensity Mapping Experiment ("CHIME").[10] See the *NSF White Paper* at Section III.C.

The new wide-band, wide-field RAS facilities are opening entirely new fields of scientific discovery. An example among those cited above is the groundbreaking CHIME radio telescope. CHIME was built to look back in cosmic distance, and hence time, to make a three-dimensional map of atomic hydrogen in the early universe. In the nearby (and hence present-day) universe, hydrogen is detected via its 1420 MHz line

---

[8] *See* SETI Institute, "Alien Telescope Array Overview," https://www.seti.org/ata/, accessed April 1, 2024, for more details.

[9] *See* Deep Synoptic Array, "The DSA-2000," https://www.deepsynoptic.org/overview, accessed April 1, 2024, for more details.

[10] *See* CHIME Collaboration, "CHIME," https://chime-experiment.ca/en, accessed April 1, 2024, for more details.

emission; these observations are protected by the RAS primary allocation noted above. This same emission line observed from sources at cosmological distance (and hence earlier cosmological epochs) is red-shifted to lower frequencies by the expansion of the universe. CHIME observes a continuous band from 400-800 MHz, thereby observing atomic hydrogen over a range of cosmic redshifts from z=0.8 to z=2.5, corresponding to look back times ranging from 7 billion to 11 billion years.[11]

The three-dimensional map of atomic hydrogen produced by CHIME will address fundamental questions about the origin and evolution of the universe. CHIME has also become the world's most efficient instrument for detecting the recently discovered fast radio bursts ("FRBs").[12] These are astrophysical events of still enigmatic origin that manifest as rapid frequency chirps, typically observed at ultra-high frequencies. The coarse localization on the sky feasible with CHIME in its original form, which did not anticipate FRB's, limited its ability to connect these events with possible source objects identified at other wavelengths. To enable enhanced localization through precise coincidence timing across large baselines, CHIME is adding three new stations, one in Canada and two in the United States at the NRQZ in West Virginia and the Hat Creek Radio Observatory in California,[13] to triangulate the locations of FRBs.[14]

---

11 The approximate age of the observable universe is 13.8 billion years.

12 D.R. Lorimer, M. Bailes, M.A. McLaughlin, D.J, Narkevic, and F. Crawford, 2019, "A Bright Millisecond Radio Burst of Extragalactic Origin," *Science* 318:777.

13 Hat Creek Radio Observatory is also the site of the Allen Telescope Array mentioned previously.

14 See O. Miller, 2020, "Unraveling the Mysteries of the Cosmos: New Telescope at Green Bank Observatory Will Improve Localization of Fast Radio Bursts," press release, West Virginia University, November 6, https://media.statler.wvu.edu/news/2020/11/06/unraveling-the-mysteries-of-the-cosmos-new-telescope-at-green-bank-observatory-will-improve-localization-of-fast-radio-bursts; and SETI Institute, 2022, "CHIME to Construct Outrigger Telescope to Search for FRBs at the Hat Creek Radio Observatory," press release, March 30, https://www.seti.org/press-release/chime-construct-outrigger-telescope-search-frbs-hat-creek-radio-observatory .

As noted in CORF's prior comments in this proceeding at page 7, many astrophysical transients such as the FRBs observed by CHIME occur irregularly in time. Thus, protecting these observations is best accomplished through spatial avoidance rather than temporal coordination. Moreover, it is reasonable to expect wide-field, wide-band radio astronomy to continue advancing in capability in the future, as astronomers follow up today's discoveries and as new phenomena are revealed by advancing technology. Spatial avoidance offers the most comprehensive protection for these future advances.

II. The Protection of RAS Under the SCS Order.

While the Report and Order ("R&O") section of the *FNPRM* primarily reserved discussion of the impact of SCS on RAS for the *FNPRM*, there was some discussion in the R&O itself of protection of RAS.

Paragraph 211 in the R&O states that under the new SCS licensing framework, "satellite operators and terrestrial licensees providing SCS will be required to comply with existing satellite and terrestrial rules to avoid harmful interference into radio astronomy and related services. In addition … space stations proposing to use SCS frequencies must obtain an FCC license under our part 25 rules prior to full-scale operation," which will "provide an opportunity for addressing concerns from federal and non-federal stakeholders related to the protection of radio astronomy and other space science services in the context of the specific proposed SCS systems." The R&O goes on to note that this licensing process will allow the Commission to "strike a reasonable balance among competing public interest benefits and narrowly tailor any remedies that may be appropriate on a case-by-case basis, taking into account the specific operational parameters." In paragraph 212, the R&O goes on to "strongly encourage applicants to conduct outreach and work with appropriate federal agency contacts in advance of submission of license applications to the Commission, including conducting Monte Carlo analyses of potential impacts to radio astronomy systems using their specific configurations, as appropriate." Such detailed analyses and advanced outreach, specifically to the spectrum management staff of NSF, and to spectrum managers in individual RAS observatories, will be helpful and promote a more efficient coordination process.

While CORF recognizes that different satellite systems could have significantly different configurations, it remains concerned about this case-by-case approach, particularly regarding the lack of clear requirements, and the procedural barriers to federal stakeholders maintaining an ongoing interaction in specific licensing proceedings. Nevertheless, one possible benefit of a case-by-case approach might be the opportunity to develop practicable avoidance measures by commencing each proposal with initial trial avoidance parameters that would be refined iteratively by the SCS provider and RAS observatory. This process should involve sharing of satellite ephemeris and activity data to facilitate attribution of harmful interference, followed by negotiation of operational adjustments by the SCS provider or measures by the RAS observatory to achieve the greatest practicable reduction of the interference. CORF urges the Commission to encourage this approach.

Other elements of the R&O impact the protection of RAS as well. For example, in establishing OOBE limits, the Commission clarified that such limits would be measured on an aggregate basis.[15] Such an approach is helpfully realistic, appropriate, and consistent with recent Commission actions in satellite proceedings.[16] CORF remains concerned that the OOBE limits adopted in Section 25.202(k)(1) [-120 dBW/m^2/MHz (i.e., -180 dBW/m^2/Hz)] are still 73 dB above the level in ITU-R RA.769 at 611 MHz (-253 dBW/m^2/Hz). However, since the new Section 25.202(k)(2) leaves the Commission the option of requiring a lower OOBE level if another service experiences harmful interference, CORF urges satellite operators to target achieving the levels in ITU-R RA.769 for OOBE into bands where RAS a primary allocation or other regulatory protection.

In paragraph 196 of the R&O, the Commission gives its rationale for declining to regulate SCS downlink power flux density ("PFD") within the licensed coverage area of the partnering terrestrial licensee, stating that it would be impractical to regulate at this level of detailed system integration. Instead, the Commission set new rules in Section 25.208(w) establishing field strength limits at and beyond the boundaries of a licensee's coverage area.[17] While this approach is sensible from the standpoint of protecting terrestrial networks, it leaves the significant concerns regarding the impact to RAS observatories unaddressed. Indeed, the *NSF White Paper* (Section IV.C, Table 10)

---

[15] R&O at para. 205.

[16] *See, e.g., Amendment of Parts 2 and 25 of the Commission's Rules to Enable GSO Fixed-Satellite Service (Space-to-Earth) Operations in the 17.3-17.8 GHz Band, to Modernize Certain Rules Applicable to 17/24 GHz BSS Space Stations, and to Establish Off-Axis Uplink Power Limits for Extended Ka-Band FSS Operations,* Report and Order, FCC 22-63, August 3, 2022, at paras. 26 and 35. Regarding calculation of the aggregate impact from multiple operators, *see, e.g., In the Matter of Space X Services, Inc. and Kepler Communications, Inc.,* 37 FCC Rcd. 7640 (2022), at para. 34.

[17] While Section 25.208(w) does not explicitly state where these limits apply, it is clear from para. 198 in the R&O that the intent is that they apply at and beyond coverage area boundaries.

notes that estimated SCS PFD levels comparable to those associated with terrestrial base stations, and consistent with industry technical filings,[18] could even exceed the damage thresholds of sensitive RAS receivers. For this reason, CORF advocates coordination via spatial avoidance as described below to the greatest extent practicable, focusing on the small number of critical facilities identified in the proposed updates to the National Telecommunications and Information Administration Manual in Attachment 1 of the *NSF White Paper*.

In paragraph 209 of the R&O, the Commission finds that it is not necessary at this time to establish minimum elevation limits for satellite downlinks. Technical needs of the SCS application, including limiting footprint elongation and minimizing path loss, are likely to set limits on the lowest practical main beam elevation. CORF suggests setting minimum main beam elevation rules corresponding to these technically driven limits, together with tapered limits on field strength associated with sidelobe emissions arriving at lower elevations. This would provide useful certainty regarding the magnitude and direction of arrival of potential interference to RAS and other incumbent services. Moreover, given that these limits would correspond to elevations below which a given satellite base station would not be intended to provide SCS service, it is reasonable to use the coverage area boundary field strength limits in Section 25.208(w) as a starting level, tapering off towards lower elevation. Section 25.208(a) provides a model for such a rule. This is an example of a case for which service-wide rules are preferable to case-by-case licensing conditions established in the R&O.

---

18 *See* Space Exploration Holdings, LLC, "Application for Modification of Authorization for the SpaceX Gen2 NGSO Satellite System to Add a Direct-to-Cellular System," IBFS File No. SAT-MOD-20230207-00021 Call Sign S3069, filed February 7, 2023, Attachment A at page 5.

III. New Rules to Protect RAS.

In the *FNPRM*, the Commission seeks comments on whether there are "additional ways to encourage and improve coordination among federal and non-federal stakeholders with respect to the coexistence of radio astronomy and SCS" and whether it should make any changes to its rules to facilitate this coordination. More specifically, in paragraph 255 the Commission states that "we seek comment on whether the unique nature of SCS may warrant additional consideration, including rule changes, related to the protection of radio astronomy." CORF asserts that the unique nature of SCS and its impact on RAS indeed warrants rule changes, and CORF recommends the changes specifically proposed in Section VI of the *NSF White Paper.*

In particular, CORF endorses an iterative licensing process based on the recommendations in Section VI of the *NSF White Paper*. That process commences with use of Monte Carlo aggregate equivalent power flux density ("EPFD") computations to enable satellite network operators to evaluate potential impacts to RAS observatories "in a comprehensive manner, taking into account a range of configurations and specified protection criteria applicability percentiles."

Next, as suggested at page 41 of the *NSF White Paper*, field testing with "provisional operation" under Special Temporary Authority ("STA"), "with possible limits on the initial spectral occupancy of SCS" should be used to test the real-world application of the prior analyses. Limiting spectral occupancy would protect against debilitating broadband interference while coordination methods are field tested.

In addition to providing protection to specific RAS facilities, this iterative process could be used to develop sufficient experience with SCS system impacts in realistic deployment scenarios to enable well-informed, uniform rules that would provide certainty to affected services and a level playing field for SCS licensees.

Similarly, CORF concurs with the suggestion in the *NSF White Paper* (page 41) that:

> The challenges posed by SCS operation are exacerbated, in part, by the large swaths of spectrum potentially impacted. Some of this spectrum has already seen significant increases in RFI for radio astronomy operations, while other parts of the bands proposed for SCS use remain viable for radio astronomy and represent significant time and investment in remote siting and previous and ongoing coordination with terrestrial operators. The minimization of frequency bandwidth for SCS operations will assist in enabling coexistence of both radio astronomy and satellite operations by minimizing bands impacted and allowing, as technology develops, mitigation through such methods as dynamic frequency operation.

CORF also concurs with the suggestion in the *NSF White Paper* (at page 41) that

> Coordination requirements—particularly requirements that lead to solutions developed early in design and development of systems, rather than, for example, requirements that lead to "reverse engineering" solutions after launch—will be both highly advantageous and, in some cases, crucial. In general, coordination will be necessary to allow for ongoing radio astronomy operations in an environment with new transmissions in a space-Earth direction.

As discussed above and in its previous filing in this proceeding, CORF believes that the most robust means of coordination would prioritize spatial avoidance over spectral or temporal measures, taking advantage of the spot beam cell architecture inherent to the SCS application. Indeed, in Reply Comments filed in this proceeding, satellite provider AST SpaceMobile, Inc., states:

> RAS stakeholders also incorrectly assume [sic] that SCS-capable satellites will employ beams with extremely wide footprints incapable of dynamic shaping. To the contrary, AST SpaceMobile's satellite architecture is designed to employ

narrow beams capable of effectively geofencing radio astronomy sites and quiet zones to the extent necessary.[19]

CORF wholeheartedly endorses this mode of coordination, as it did in its prior comments in this proceeding. The degree of avoidance (PFD reduction) required to be achieved at the coordinated RAS facility would depend on the nature of that facility and its susceptibility to interference. CORF recommends reference to the *NSF White Paper* at Section II.D, which notes that for useful guidance in establishing appropriate total PFD and spectral PFD limits, expert input from the coordinated facilities will be required. In view of the AST SpaceMobile comments cited above, it is realistic to expect that high PFD reduction can be achieved at a coordinated RAS site via shaping and steering of adjacent cell spot beams to place beam nulls on the RAS site.[20]

Lastly, CORF urges the Commission to modify Section 1.924(a) of the Commission's rules to expand the NRQZ to include protection from spaceborne transmitters and to create rules conferring protection from spaceborne transmissions on other major RAS facilities, all of which will be significantly more vulnerable to satellite interference under the new SCS regulatory framework. This expanded protection should include all of the observatories listed in Attachment 1 to the *NSF White Paper*, with the same geographic parameters set forth therein.

It is clear that due to the growth of satellite technology, and the implementation of SCS, Section 1.924(a) of the Commission's rules must address satellite operations.

---

[19] Reply Comments of AST SpaceMobile, Inc., GN Docket No. 23-65, June 12, 2023, at pages 12-13.

[20] CORF recognizes that a key benefit of SCS may be enhanced access to emergency services. For this reason, assuming spatial avoidance of full-service spot beam cells is achieved at a coordinated RAS site, it may be desirable to allocate a low-capacity "weak cell" spot beam to cover the RAS facility and the surrounding area with the minimum possible spectral occupancy to provide low-bandwidth emergency text and voice service. Part of the coordination process would be to assess whether such service is necessary at that site to access emergency services, and if so what frequency use in the weak cell would have the minimum impact on RAS observations.

CORF strongly recommends that Section 1.924(a) be revised to specifically address satellite to cellphone operations,[21] including both uplinks and downlinks.[22] It is a historical anomaly that the rule has not previously been modified to address the more limited operations of the 1.6/2.4 GHz Mobile Satellite Service ("MSS"), but SCS could radically increase the likelihood of interference to radio astronomy observations, due to the substantially higher number of ordinary cell phones that would be able to engage in SCS, compared with the limited number of 1.6 GHz MSS handsets.

The FCC's recent *Lynk Order*[23] should be considered in this proceeding. Specifically, the Commission conditioned the grant of the Lynk authorization on "Lynk avoiding space-to-Earth transmissions into Radio Quiet Zones throughout the frequency range authorized in this grant and on a global basis consistent with protection measures necessary for individual Radio Quiet Zones."[24] This provides a recent and directly applicable policy precedent for modifying Section 1.924(a) of the Commission's rules to apply to SCS.[25]

---

[21] *Cf. NTIA Report to Congress on Activities on Ensuring Spectrum Access for Radio Astronomy (FY 2018 and FY 2019), September 17, 2019***,** at page 3, available at https://www.ntia.gov/report/2019/ntia-activities-ensuring-spectrum-access-radio-astronomy-fy-2018-and-fy-2019 (last viewed March 27, 2024), recommending "[a]dding geographical protections from airborne transmitters to the NRQZ, where the Green Bank, West Virginia, Observatory resides. Established by the FCC and the IRAC in 1958 to minimize harmful interference to sensitive radio astronomy telescopes and to facilities operated by other government agencies, the NRQZ has served its purpose for over 60 years. However, the rules set forth in 1958 are no longer adequate to protect the Green Bank Telescope, which resides in the NRQZ, from airborne transmissions, such as airplanes, satellites, and unmanned aerial vehicles. The U.S. scientific community will need updated rules for the NRQZ that consider the modern progress of technology. Where possible, airborne transmissions should be minimized or coordinated."

[22] A revised rule should also address satellite telemetry, tracking, and command (TT&C) operations where applicable, as well as any "ancillary terrestrial components" of SCS service.

[23] *In the Matter of Lynk Global, Inc.* 37 FCC Rcd. 10681 (2022) ("*Lynk Order*").

[24] *Lynk Order* at para. 25.

[25] While requiring compliance with Quiet Zone requirements in international operations, the *Lynk Order* did not specifically require Lynk to comply with Section 1.924 because the *Order* did not authorize transmissions into the United States.

IV. Conclusion

It is commendable that the Commission is seeking ways to protect vulnerable radio astronomy observations in the context of the regulatory framework for SCS. By fundamentally changing the RFI environment experienced by RAS observatories in heretofore remote locations, SCS may severely curtail the ability of RAS observatories to perform broadband surveys and targeted observations that are driving leading-edge science now, and that are the basis of major projects currently in planning. For this reason, the Commission should include specific protections for radio astronomy in SCS regulations, as discussed above.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

Marcia McNutt

By: ______________________________
Marcia McNutt
President, National Academy of Sciences

Direct correspondence to:

CORF
Keck Center of the National Academies
of Sciences, Engineering, and Medicine
500 Fifth Street, NW, Keck 954
Washington, D.C. 20001
(202) 334-3520

April 30, 2024

Appendix

Committee on Radio Frequencies

Members

Nathaniel J. Livesey, Jet Propulsion Laboratory, California Institute of Technology, *Chair*

Scott Paine, Center for Astrophysics | Harvard & Smithsonian, *Vice Chair*

Nancy L. Baker, Naval Research Laboratory

Laura B. Chomiuk, Michigan State University

Kshitija Deshpande, Embry-Riddle Aeronautical University

Dara Entekhabi, Massachusetts Institute of Technology

Philip J. Erickson, Haystack Observatory, Massachusetts Institute of Technology

Kelsey E. Johnson, University of Virginia

Christopher Kidd, University of Maryland and NASA Goddard Space Flight Center

Karen L. Masters, Haverford College

Mahta Moghaddam, University of Southern California

Bang D. Nhan, National Radio Astronomy Observatory (Virginia)

Consultants

Tomas E. Gergely, retired

Staff

Christopher J. Jones, Responsible Staff Officer