

Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of)
Spectrum Rules and Policies for the Operation of) WT Docket No. 22-323
Unmanned Aircraft Systems)
Petition of AIA for Rulemaking to Adopt Service) RM-11798 (terminated)
Rules for Unmanned Aircraft Systems Command)
and Control in the 5030-5091 MHz Band)

NOTICE OF PROPOSED RULEMAKING

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By the Commission: Commissioner Starks issuing a statement.

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I. INTRODUCTION

1. Unmanned aircraft are being used to deliver consumer packages and life-saving medical supplies, facilitate the rapid restoration of power infrastructure after a storm, and aid in first responder missions such as search and rescue and wildfire management, among innumerable other beneficial public and private uses. These operations depend on wireless communications for purposes ranging from flight control communications between a ground-based control station and the unmanned aircraft (UA) (hereinafter referenced collectively in this Notice of Proposed Rulemaking (NPRM) as an unmanned aircraft system or UAS) to the delivery of mission-related payload information from the UA.¹ In this NPRM, we take several steps to promote access by UA operators to licensed spectrum for these purposes.

2. First, we address the 5030-5091 MHz band, which the Commission previously allocated to support terrestrial control links for UAS without adopting service rules. Because technical work regarding UAS is still in a nascent stage, we anticipate that service rules sufficient to facilitate UAS operations will likely require development in phases. We now take the first step to develop such rules. We seek comment on service rules for the 5030-5091 MHz band that will provide UAS operators with access to licensed spectrum with the reliability necessary to support safety-critical UAS communications links. Second, due to the increasing interest in operating UAS using existing terrestrial flexible-use spectrum networks, we seek comment on whether the Commission's rules are adequate to ensure co-existence of terrestrial mobile operations and UAS use or whether changes to our rules are necessary.² Third, to further promote the safe integration of unmanned aircraft operations in controlled airspace and facilitate flight coordination, we propose a process for UAS operators to obtain a license in the aeronautical VHF band to communicate with air traffic control and other aircraft. Together, these measures will help to promote the growth and safety of UAS operations.³

3. This proceeding implicates the jurisdiction and concerns of multiple federal agencies. The Federal Aviation Administration (FAA) has the jurisdictional responsibility to ensure the safety of aircraft, including UAS, and is tasked by statute with the safe integration of UAS into the National Airspace System.⁴ The National Telecommunications and Information Administration (NTIA), which

¹ More specifically, we use the term unmanned aircraft system(s) (UAS) in this NPRM to reference a UA together with all the associated elements (including communication links and the components that control the UA) that are required for the safe and efficient operation of the UA in the airspace of the United States. As discussed below, we seek comment on our proposal to adopt this definition of "unmanned aircraft system" for the 5030-5091 MHz band service rules.

² To this end, we seek comment on the sufficiency of the current flexible-use rules to prevent interference to and from UAS operations, and on whether we can eliminate the current prohibitions on airborne operations applicable to certain of these flexible-use bands.

³ We note that AURA Network Systems OpCo, LLC and A2G Communications, LLC, have a pending petition for rulemaking requesting rule changes to allow the 450 MHz General Aviation Air-Ground Radiotelephone Service band to be used for a broader range of services, including data communications with UAS. *See* Petition for Rulemaking by AURA Network Systems OpCo, LLC and A2G Communications, LLC to Permit the Transmission of Data in Air-Ground Radio Telephone Automated Service Channels Between 454.675-454.975 MHz and 459.675-459.975 MHz, RM-1912 (filed Feb. 16, 2021) (AURA/A2G Petition). We expect to address the AURA/A2G Petition in another proceeding.

⁴ *See* 49 U.S.C. § 44802. The National Airspace System consists of (1) a network of both controlled and uncontrolled airspace, (2) air navigation facilities, equipment and services, (3) airports and landing areas, (4) aeronautical charts, information and services, (5) rules and regulations, (6) procedures and technical information, and (7) manpower and material. *See* FAA, *National Airspace System*, https://www.faa.gov/air_traffic/nas/ (last visited Sept. 6, 2022).

administers the federal use of spectrum, has jurisdictional interests in the 5030-5091 MHz band, including potentially using the band for federal UAS operations and ensuring the adequate protection of certain other federal uses in and adjacent to the 5030-5091 MHz band. As a part of their respective jurisdictional responsibilities, both the FAA and NTIA have been examining the potential use of the 5030-5091 MHz band for UAS operations, and the FAA has adopted a minimum performance standard for UAS radio equipment operating in the 5040-5050 MHz sub-band of the 5030-5091 MHz band.⁵ Accordingly, a whole-of-government approach is needed to ensure that this proceeding addresses the relevant concerns and issues within the responsibility of each stakeholder agency and that our efforts in this area work in complement with those of our federal partners to support and promote the safe and productive operation of UAS. To facilitate this approach, we have consulted with these agencies in the preparation of this NPRM, and will continue to do so as the proceeding advances.

II. UAS COMMUNICATIONS IN THE 5030-5091 MHZ BAND

A. Background

4. Because a UA, to the extent its route is not pre-programmed, must be operated remotely, the operator depends critically on wireless communications between a ground-based control station and the UA to control the flight of the UA, including communications to send commands to the aircraft and to receive telemetry and other data from it. UAS also increasingly employ wireless signals for other safety-related purposes, such as to detect and avoid other aircraft. Currently, no spectrum is licensed in the United States exclusively for UAS communications, and operators have generally relied on unlicensed operations or experimental licenses. Neither of these spectrum resources provide the user with any right to protection from harmful interference, and as a result, the reliability of communications using these resources can be uncertain. As UA flights increasingly involve operations with a higher risk profile, such as flights that use large aircraft, carry heavy cargo or human passengers, or travel into the controlled airspace used by commercial passenger aircraft,⁶ operators have a growing need for the greater reliability that interference-protected licensed spectrum provides for control-related and other safety-related communications.

⁵ The FAA's actions to integrate UAS into the National Airspace System have also involved many regulatory efforts not specific to the 5030-5091 MHz band. For example, in 2016, the FAA, together with the Office of the Secretary of Transportation, adopted rules authorizing the routine operation of small UAs (those weighing less than 55 pounds), subject to certain restrictions and limitations. *See* Federal Aviation Administration and Office of the Secretary of Transportation, Department of Transportation, Operation and Certification of Small Unmanned Aircraft Systems, 81 Fed. Reg. 42064 (June 28, 2016) (to be codified at 14 CFR pts. 21, 43, 61, 91, 101, 107, 119, 133, 183). Among other restrictions, the rules did not permit such operations over people or at night without an individual waiver. *See id.* at 42102, 42123. Subsequently, the FAA modified these regulations and authorized routine operations of small UAs over people and operation at night under certain circumstances. *See* Federal Aviation Administration and Office of the Secretary of Transportation, Department of Transportation, Operation of Small Unmanned Aircraft Systems Over People, 86 Fed. Reg. 4314, 4314-15 (Jan. 15, 2021). At the same time, the FAA also adopted rules establishing requirements for the remote identification of UAs operating in the United States. *See* Federal Aviation Administration, Remote Identification of Unmanned Aircraft, 86 Fed. Reg. 4390 (Jan. 15, 2021) (*Remote ID Rules*).

⁶ The FAA defines "controlled airspace" as "an airspace of defined dimensions within which air traffic control service is provided to [instrument flight rules] flights and to [visual flight rule] flights in accordance with the airspace classification. NOTE: Controlled airspace is a generic term that covers Class A, Class B, Class C, Class D, and Class E airspace." 14 CFR § 1.1 (General Definitions). Controlled airspace is found around some airports and at certain altitudes where air traffic controllers are actively communicating with, directing, and separating all air traffic. *See* FAA, *Airspace 101: Rules of the Sky*, https://www.faa.gov/uas/recreational_fliers/where_can_i_fly/airspace_101/ (last visited Sept. 6, 2022).

5. In 2017, the Commission determined that the 5030-5091 MHz band should be allocated to help address that need.⁷ Prior to the 2012 World Radiocommunication Conference (WRC-12), the 5030-5091 MHz band was allocated both internationally and in the United States to the aeronautical mobile-satellite (route) service (AMS(R)S) and the aeronautical radionavigation service (ARNS) on a primary basis.⁸ Footnote 5.444 of the Table of Frequency Allocations further provides that the spectrum is to be used for the operation of the international standard system (microwave landing system) for precision approach and landing and gives microwave landing systems priority over other uses of the band.⁹ At the 2012 World Radiocommunication Conference, the United States proposed that the 5030-5091 MHz band also be allocated to the aeronautical mobile (route) service (AM(R)S) on a primary basis in order to support terrestrial control links for UAS, in light of (1) the anticipated growth of UAS operations, (2) the limited use of the band worldwide at that time, and (3) the lack of microwave landing system deployment in the United States at 5030-5091 MHz.¹⁰ Consistent with the United States proposal, the 2012 World Radiocommunication Conference allocated the 5030-5091 MHz band internationally to the AM(R)S on a primary basis in all Regions.¹¹

6. In 2017, the Commission adopted a Report and Order taking several steps in response to the decisions from the 2012 World Radio Conference.¹² Among other measures, the Commission mirrored the international allocation at 5030-5091 MHz in its domestic allocations, specifically allocating the 5030-5091 MHz band to the AM(R)S on a primary basis for both federal and non-federal use.¹³ Under the Commission rules, “AM(R)S” is defined as “[a]n aeronautical mobile service reserved for communications relating to safety and regularity of flight, primarily along national or international civil air routes.”¹⁴ The Commission found that adopting the new AM(R)S allocation would “support the

⁷ See *Amendment of Parts 2, 15, 80, 90, 97, and 101 of the Commission’s Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2012) (WRC-12), Other Allocation Issues, and Related Rule Updates*, ET Docket No. 15-99, Report and Order, 32 FCC Rcd 2703, 2717, para. 42 (2017) (*WRC-12 R&O*).

⁸ See *Amendment of Parts 1, 2, 15, 25, 27, 74, 78, 80, 87, 90, 97, and 101 of the Commission’s Rules Regarding Implementation of the Final Acts of the World Radiocommunication Conference (Geneva, 2007) (WRC-07), Other Allocation Issues, and Related Rule Updates et al.*, ET Docket No. 12-338, et al., Report and Order, Order, and Notice of Proposed Rulemaking, 30 FCC Rcd 4183, 4262, paras. 223-24 (2015) (*WRC-12 NPRM*); 47 CFR § 2.106. Under the Commission’s Table of Frequency Allocations rules, Aeronautical Mobile-Satellite Route Service (AMS(R)S) is defined as “[a]n aeronautical mobile-satellite service reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes.” 47 CFR § 2.1(c). Aeronautical Radionavigation Service (ARS) is defined as “[a] radio-navigation service intended for the benefit and for the safe operation of aircraft.” *Id.*

⁹ See 47 CFR § 2.106, footnote 5.444.

¹⁰ See *WRC-12 NPRM*, 30 FCC Rcd at 4262, para. 225.

¹¹ See *WRC-12 NPRM*, 30 FCC Rcd at 4263, para. 226.

¹² See generally *WRC-12 R&O*.

¹³ See *WRC-12 R&O*, 32 FCC Rcd at 2717, para. 41. The status of “primary” gives AM(R)S priority over any services allocated on a “secondary” basis, see 47 CFR § 2.105(c)(2), but AM(R)S remains subject to the higher priority of MLS provided by Footnote 5.444. See 47 CFR § 2.106, footnote 5.444. The Commission also added Footnote 5.443C to this allocation band limiting its use to internationally standardized aeronautical systems and setting limits for unwanted emissions from AM(R)S stations to adjacent band radionavigation-satellite service (RNSS) downlinks to an EIRP density of -75 dBW/MHz. See *WRC-12 R&O*, 32 FCC Rcd at 2717, para. 41; see also 47 CFR § 2.106, footnote 5.443C.

¹⁴ 47 CFR § 2.1(c). The Commission defines the term “aeronautical mobile service,” in relevant part, as “[a] mobile service between aeronautical stations and aircraft stations, or between aircraft stations[.]” *Id.* An aeronautical

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anticipated growth of UAS and promote their safe operation.”¹⁵ The Commission did not adopt any rules to license or govern UAS services in the band, however; instead, it stated that “[t]echnical and operational rules relating to altitude, weight, or other requirements will be addressed in the service rules for this band, which will be promulgated in a separate proceeding.”¹⁶

7. *AIA Petition for Rulemaking.* On February 8, 2018, the Aerospace Industries Association (AIA) filed a petition for rulemaking recommending licensing and service rules for control-and-non-payload communications (CNPC) links in the 5030-5091 MHz band to support UAS operations in the United States (AIA Petition).¹⁷ AIA proposed that individual UAS operators that meet certain qualifications or organizations that employed such operators be able to obtain a non-exclusive, nationwide Commission spectrum license, which would authorize them to use the 5030-5091 MHz band for UAS CNPC subject to a dynamic frequency assignment process.¹⁸ AIA further recommended the Minimum Operational Performance Standards (MOPS) for UAS CNPC links issued by RTCA in 2016 and designated as RTCA DO-362 as a “good starting point for the Commission’s consideration of licensing and operational rules[.]”¹⁹ Noting that the AM(R)S allocation of the band is limited to “communications

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station is defined as “[a] land station in the aeronautical mobile service.” *Id.* An aircraft station is defined as “[a] mobile station in the aeronautical mobile service, other than a survival craft station, located on board an aircraft.” *Id.*

¹⁵ See *WRC-12 R&O*, 32 FCC Rcd at 2717, para. 42; see also *id.* at 2704, para. 1 (stating that “AM(R)S use of the 5030-5091 MHz band will support unmanned aircraft systems”).

¹⁶ See *WRC-12 R&O*, 32 FCC Rcd at 2717, para. 42.

¹⁷ See Petition of AIA for Rulemaking to Adopt Service Rules for Unmanned Aircraft Systems (“UAS”) Command and Control in the 5030-5091 MHz Band, RM-11798 (filed Feb. 8, 2018) (AIA Petition).

¹⁸ See AIA Petition at 6-7, 9-10. In its petition, AIA used the terms “control-and-non-payload” and “command-and-control” (or C2) interchangeably. See, e.g., AIA Petition at 7 (referring to “CNPC links”), 8 (referring to “C2 communications links”). We similarly do so throughout this NPRM.

¹⁹ See AIA Petition at 7. RTCA is a standards development organization that works with the FAA to develop standards that can be used as means of compliance with FAA regulations. See RTCA, *About Us*, <https://www.rtca.org/about/> (last visited Sept. 6, 2022). RTCA Special Committees (SCs) develop Minimum Operational Performance Standards (MOPS) among other standards documents related to aviation. See RTCA, *Standards & Guidance Materials Descriptions*, <https://www.rtca.org/standards/standards-guidance-materials/> (last visited Sept. 6, 2022). According to RTCA’s website, “MOPS provide standards for specific equipment(s) useful to designers, manufacturers, installers and users of the equipment. . . . MOPS provide the information needed to understand the rationale for equipment characteristics and requirements stated, describe typical equipment applications and operational goals, and establish the basis for required performance under the standard. Definitions and assumptions essential to proper understanding are provided as well as installed equipment tests and operational performance characteristics for equipment installations.” *Id.* RTCA MOPS are often referenced as a basis for equipment certification in FAA technical standard orders. See *id.* Technical standard orders establish minimum performance standards for specified materials, parts, and appliances used on civil aircraft. See FAA, *Technical Standard Orders (TSO)*, https://www.faa.gov/aircraft/air_cert/design_approvals/tso/ (last visited Sept. 6, 2022).

RTCA’s Special Committee 228 (SC-228), established on May 20, 2013, is working to develop, among other things, Command-and-Control Data Link MOPS for the 5030-5091 MHz band. See RTCA, *SC-228, Minimum Performance Standards for Unmanned Aircraft Systems*, <https://www.rtca.org/content/sc-228> (last visited Sept. 6, 2022). The committee published the first version in September 2016 with the release of DO-362, Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial) (RTCA DO-362). In response, the FAA adopted Technical Standard Order C213, Unmanned Aircraft Systems Control and Non-Payload Communications Terrestrial Link System Radios, effective March 9, 2018. See Federal Aviation Administration, Aircraft Certification Service, Technical Standard Order C213, Unmanned Aircraft Systems Control and Non-Payload Communications Terrestrial Link System Radios (2018) (TSO-C213). TSO-C213 adopted the RTCA DO-362 standard as a minimum performance standard for new models of UAS CNPC Link System radios operating in the 5040-5050 MHz portion of the 5030-5091 MHz band. See TSO-C213 at 1. On December 20, 2022, the FAA

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relating to safety and regularity of flight,” AIA also advocated for prohibiting any non-UAS use of the 5030-5091 MHz band or any UAS use for “payload communications or other non-safety or non-route services.”²⁰

8. The Commission sought public comment on AIA’s petition on April 26, 2018.²¹ Eight parties filed comments, and four filed replies.²² The majority of commenters supported commencement of a rulemaking to license the 5030-5091 MHz band for UAS communications, and several supported aspects of the AIA proposal.²³ Some raised concerns, however, that the proposal was too restrictive in the operations it would support or permit and that the 5030-5091 MHz band would not in any case be able to support all UAS operations; those commenters recommended that the Commission not preclude use of other bands for UAS operations.²⁴

9. *Section 374 Report.* Section 374 of the FAA Reauthorization Act of 2018 directs the FAA, the FCC, and NTIA to submit a report to specified committees of the House and Senate on, among other things, “whether [UAS] operations should be permitted, but not required, to operate on [the 5030-5091 MHz band] on an unlicensed, shared, or exclusive basis, for operations within the [UAS Traffic Management] system or outside of such a system.”²⁵ On November 25, 2019, the Office of Engineering and Technology (OET) and the Wireless Telecommunications Bureau (WTB) (collectively, the Bureaus) sought public comment on this issue and others identified in Section 374 of the FAA Reauthorization Act (*Section 374 Public Notice*).²⁶ Twenty-three parties filed comments, and eleven filed replies.²⁷ On August 20, 2020, the Bureaus jointly submitted a report to Congress on behalf of the Commission addressing the matters specified in Section 374.²⁸ In their report, the Bureaus found that “[t]he 5030-5091

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issued a revision of TSO-C213, designated TSO-C213a. See Federal Aviation Administration, Aircraft Certification Service, Technical Standard Order C213a, Unmanned Aircraft Systems Control and Non-Payload Communications Terrestrial Link System (2022) (TSO-C213a), available at FAA, *Technical Standard Orders*, <https://drs.faa.gov/browse/TSO/doctypeDetails>. TSO-C213a replaces TSO-C213 going forward, adopting aspects of RTCA DO-362A, the second version of the RTCA MOPS for the 5030-5091 MHz band, as a minimum performance standards for CNPC Link Systems designed for operations within any spectrum in the 5030-5091 MHz band. See TSO-C213a at 2; RTCA, Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial), RTCA-DO-362A (2020) (RTCA DO-362A).

²⁰ AIA Petition at 10.

²¹ See *Consumer & Governmental Affairs Bureau Reference Information Center Petition for Rulemakings Filed*, Public Notice, Report No. 3089 (CGB Apr. 26, 2018), <https://docs.fcc.gov/public/attachments/DOC-350441A1.pdf>.

²² Parties that filed comments and reply comments in response to the AIA Petition are listed in Appendix C.

²³ See Elefante Group *AIA Petition* Comments at 1-2 (supporting petition framework as a “starting point”); Integrity Communications *AIA Petition* Comments at 1 (same); Raytheon *AIA Petition* Comments at 1-2 (same); see also Boeing *AIA Petition* Comments at 1; Lockheed Martin *AIA Petition* Comments at 1; RTCA SC-228 *AIA Petition* Comments at 1; Aero Vironment *AIA Petition* Reply at 1; Rockwell Collins *AIA Petition* Reply at 1.

²⁴ See CTIA *AIA Petition* Comments at 7-9; see also AURA *AIA Petition* Comments at 2; Small UAV Coalition *AIA Petition* Comments at 3.

²⁵ See FAA Reauthorization Act of 2018, § 374, Pub. L. No. 115-254, 132 Stat. 3186, 3313-14 (2018) (Section 374).

²⁶ See *Wireless Telecommunications Bureau and Office of Engineering and Technology Seek Comment on Unmanned Aerial System Operations in the 960-1164 MHz and 5030-5091 MHz Bands, Pursuant to Section 374 of the FAA Reauthorization Act of 2018*, GN Docket No. 19-356, Public Notice, 34 FCC Rcd 11038 (WTB/OET 2019) (*Section 374 Public Notice*).

²⁷ Parties that filed comments and reply comments in the *Section 374* proceeding are listed in Appendix C.

²⁸ See WTB & OET, Report on Section 374 of the FAA Reauthorization Act of 2018, GN Docket No. 19-356, 1 (2020), <https://docs.fcc.gov/public/attachments/DOC-366460A1.pdf> (*Section 374 Report*). The *Section 374 Report* (continued....)

MHz band appears to offer promise for intensive UAS use because it is unencumbered”²⁹ and “recommend[ed] that the Commission initiate a rulemaking proceeding to develop service and licensing rules enabling UAS use of the 5030-5091 MHz band in collaboration with the FAA and NTIA.”³⁰

10. *Refresh Public Notice*. On August 20, 2021, WTB released a public notice to update the record on AIA’s proposal to reflect developments since 2018 and to further develop the record on certain aspects of the proposal.³¹ The Bureau received 24 comments and four reply comments in response to the *Refresh Public Notice*.³²

B. Discussion

11. As reflected in the comments to the AIA Petition and the record in response to the *Refresh Public Notice*, UAS manufacturers and other stakeholders have continued to express strong interest in a proceeding to enable licensing of the 5030-5091 MHz band for UAS CNPC links since the Commission added an AM(R)S allocation in the 5030-5091 MHz band to enable interference-protected UAS communications.³³ The *Section 374 Report* released by WTB and OET in 2020 also supports the commencement of a rulemaking proceeding to adopt service rules enabling UAS operations in the 5030-5091 MHz band.³⁴ Accordingly, we propose to adopt a band plan and service rules in the 5030-5091 MHz band to enable UAS operators to use interference-protected CNPC links. We seek comment on our proposal and on options to make the band available for this purpose. We further seek comment on the costs and benefits of any such options, including the costs and benefits of the specific band plan and service rules options discussed below. UAS platforms offer potential benefits in particular to disadvantaged, remote and rural communities, including delivery of essential goods or medical and other critical supplies in hard-to-reach areas, as well as innovative agricultural uses. We seek comment on measures that will facilitate UAS use and promote equity for these underserved populations. We encourage stakeholders to develop and submit consensus recommendations on service rules for the 5030-5091 MHz band, including recommendations on the issues and proposals discussed below.

12. We do not intend to mandate that all UAS CNPC occur exclusively in the 5030-5091 MHz band. Other licensed bands, including the flexible-use bands where mobile networks are already deployed nationwide and the 450 MHz General Aviation Air-Ground band, are being explored as platforms for UAS operations, including UAS CNPC. Commenters in this proceeding broadly support the availability of these bands as resources to help meet the rapidly growing spectrum access needs of the UAS community.³⁵ In addressing the 5030-5091 MHz service rules, we do not propose to mandate that all CNPC occur within the band, nor do we intend that the future rules adopted in this proceeding for 5030-5091 MHz will necessarily govern any UAS operations in other bands. Rather, through this proceeding, we seek to provide UAS operators with access to an additional spectrum resource that may complement other spectrum resources that are currently available or in development. The 5030-5091

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stated that separate reports to Congress were anticipated from the NTIA and FAA regarding matters under their respective areas of authority. *Section 374 Report* at 2.

²⁹ *Section 374 Report* at 12.

³⁰ *Id.* at 1.

³¹ See *Wireless Telecommunications Bureau Seeks to Refresh the Record on Unmanned Aircraft Systems Use of the 5 GHz Band*, RM-11798, Public Notice, 36 FCC Rcd 12706 (WTB 2021) (*Refresh Public Notice*).

³² Parties that filed comments and reply comments in response to the *Refresh Public Notice* are listed in Appendix C.

³³ See, e.g., AIA *Refresh PN* Comments at 1-3; ASRI *Refresh PN* Comments at 1, 4; AURA *Refresh PN* Comments at 1; Aero Vironment *Refresh PN* Comments at 1; CDA *Refresh PN* Comments at 1; EEI *Refresh PN* Comments at 1; FPL *Refresh PN* Comments at 4; Qualcomm *Refresh PN* Comments at 1.

³⁴ *Section 374 Report* at 1, 12.

³⁵ See *infra* n.255.

MHz band is a limited resource, and the demand for protected UAS CNPC may well exceed the capacity of the band as UAS operations increase over time.³⁶ Further, while existing networks operating in other bands such as flexible-use bands may provide sufficient reliability for many UAS use cases, authorization of the 5030-5091 MHz band for UAS use offers an opportunity to apply standards and rules designed to meet even the most safety-critical communications needs.³⁷ In addition, as we discuss below, technical standards have already been developed for the 5030-5091 MHz band specifically to support reliable UAS CNPC, whereas work is still nascent to establish or demonstrate the reliability of CNPC standards or operations in other bands. As a result, the 5030-5091 MHz band has the potential to be available for safety-critical aviation needs more quickly than licensed spectrum in these other bands. We tentatively conclude that, while other spectrum bands are available for UAS communications, licensing the 5030-5091 MHz band specifically for UAS CNPC will have important public interest benefits. We seek comment on this tentative conclusion and the extent to which the 5030-5091 MHz band may offer unique advantages over other bands in supporting UAS CNPC.

1. Band Plan

13. Below, we seek comment on an appropriate band plan for communications to support the growth and safety of UAS operations. For the purpose of this band and its service rules, and consistent with the FAA definitions of the terms, we propose to define UAS as an unmanned aircraft (UA) and its associated elements (including communication links and the components that control the UA) that are required for the safe and efficient operation of the UA in the airspace of the United States, and to define a UA as an aircraft operated without the possibility of direct human intervention from within or on the aircraft.³⁸ We seek comment on these proposed definitions and on any alternatives. We further identify two broad UAS use cases for purposes of determining the appropriate band plan and service rules – non-networked operations, generally occurring within radio-line-of-sight³⁹ of the UAS operator, and network-supported operations, which rely on network infrastructure to go beyond radio-line-of-sight of the operator. Non-networked operations involve flights within a sufficiently localized area that can rely on direct wireless links between the UAS operator’s controller and the UA and therefore do not require any supporting network infrastructure. Such operations may include, for example, tower or other site

³⁶ See Letter from John W. Kuzin, Vice President, Spectrum Policy & Regulatory Counsel, Qualcomm, to Marlene Dortch, Secretary, FCC, RM-11798 (filed Mar. 15, 2022) (Qualcomm Mar. 15, 2022 *Ex Parte*). Qualcomm performed simulations that purport to show that, as the number of UAS per “cell” increases, both uplink data throughput and uplink latency increase to levels that may exceed acceptable target values. See *id.*, Attach. at 12-17. To combat these capacity issues in the 5030-5091 MHz band, Qualcomm suggests that terrestrial mobile networks in other bands could be utilized for lower altitude operations and offloaded to the 5030-5091 MHz band above a certain height threshold. See *id.*, Attach. at 22.

³⁷ See, e.g., ASRI *Refresh PN* Comments at 1 (asserting that the 5030-5091 MHz band is central to successful UAS development and advancement, “particularly for larger UAS operating in [FAA]-controlled airspace”).

³⁸ See 14 CFR § 1.1; accord 49 U.S.C. § 44801(11), (12) (defining “unmanned aircraft” and “unmanned aircraft system”). While our rule proposal thus focuses use of the band on communications for the operation of a type of aircraft, which meets the definition of a part 87 aviation service, see 47 CFR § 87.5, we note that a network-based communications service offered to operators of UAS would typically also be a commercial service providing access to wide-area networks, in contrast to the largely if not entirely non-commercial and non-network-based services regulated under part 87. See generally 47 CFR pt. 87. Below, we seek comment on the regulatory treatment of these services, including their placement in the organization of our rules. See, e.g., *infra* paras. 70-73.

³⁹ References to “line-of-sight” herein correspond to radio-line-of-sight. This is in contrast to FAA rules, which consider whether UAS operations are within visual-line-of-sight rather than radio-line-of-sight. See 14 CFR § 107.31. We focus on whether a UA is beyond-radio-line-of-sight in this context because the suitability of the different licensing approaches we consider below (direct link connections as opposed to network-based connections) appears to depend to a greater extent on whether an operation is within radio-line-of-sight of the operator than on whether or not an operation is in visual sight of the operator. A UA that is beyond-visual-line-of-sight but within radio-line-of-sight can still be controlled by a direct wireless link between the controller’s radio and the UA.

inspections, public safety operations, or localized surveillance. In contrast, network-supported operations rely on deployed network infrastructure, such as cell towers and sites, to relay information between the operator and the UA and may therefore extend far beyond the range of direct wireless links between operator and UA.⁴⁰ While UAS operations have in the past been predominantly non-networked operations, there is growing interest in and exploration of network-supported operations, such as for package delivery, mapping, search-and-rescue, long-range infrastructure inspections (e.g., involving railroad tracks, power distribution infrastructure, or pipelines) and long-range surveillance flights.⁴¹ We find substantial support in the response to the *Refresh Public Notice* for both use cases.⁴² We seek comment on whether any other UAS use cases should be considered in determining the appropriate band plan and service rules.

14. Hereinafter, we use the term Non-Networked Access (NNA) to indicate spectrum or licenses (e.g., NNA blocks) that would be governed by service rules appropriate to support non-networked communications.⁴³ Likewise, we use the term Network-Supported Service (NSS) in connection with spectrum or licenses to indicate that the relevant spectrum or licenses would be governed by service rules appropriate to support the provision of network-based services.⁴⁴ Further, we propose to use NNA and NSS in the rules to designate the spectrum allocated for non-networked and network-supported use cases, respectively.

15. AIA suggests that RTCA's terminology for these two use cases should be used.⁴⁵ RTCA uses the term "point-to-point" for non-networked communications links and the term "Command-and-Control Communications Service Providers" to describe network-supported services.⁴⁶ We tentatively find that our proposed terminology is more descriptive of the use cases we seek to support, and that the use of the term point-to-point, which has been long used in Commission rules and orders to reference systems providing a data communication link between two fixed stations, may itself contribute to confusion in this context.⁴⁷ We seek comment on the proposed terminology, and on alternatives.

16. To accommodate both NNA and NSS in the 5030-5091 MHz band, we propose to partition the band, to dedicate different segments of spectrum in the band for each use case, and to license each of these segments in a manner that is appropriate to support the relevant use cases. We seek comment broadly on the placement of NNA and NSS spectrum to ensure efficient, reliable, and safe use of the band. We seek comment on whether to make spectrum available for multi-purpose uses, e.g.,

⁴⁰ See, e.g., CTIA *Refresh PN* Comments at 11 ("To the extent this band is to be used for [beyond-line-of-sight], the spectrum will either need to be deployed on existing nationwide infrastructure, or brand-new infrastructure that can accommodate UAS flight over long distances."). Such operations have also relied on satellite-based connections or, in some cases, autonomous aircraft that do not require radio control.

⁴¹ See, e.g., Small UAV Coalition *Section 374 Report* Comments at 2-4 (discussing recent tests and studies involving beyond-visual-line-of-sight operations); T-Mobile *Section 374 Report* Comments at 2 (stating that T-Mobile has been selected to work with three state and local departments of transportation to explore how its LTE network can be used to support advanced drone operations, including beyond-visual-line-of-sight flying).

⁴² See, e.g., AIA *Refresh PN* Comments at 5; EEI *Refresh PN* Comments at 5 (supporting licensing for beyond-radio-line-of-sight operations); L3H *Refresh PN* Comments at 18; RTCA *Refresh PN* Comments at 3.

⁴³ We seek comment elsewhere on whether the scope of permitted services should encompass types of communications other than CNPC.

⁴⁴ Network-supported operations will require a different licensing approach than non-networked access due to the need in the former case to provide the regulatory framework and incentives to support the investment in and deployment of substantial network infrastructure.

⁴⁵ See AIA *Refresh PN* Comments at 5.

⁴⁶ See *id.* at 5.

⁴⁷ See, e.g., 47 CFR pt. 101, subpts. H, I.

expansion bands for temporary NNA or NSS use. For example, an NSS licensee operating a network in one of the NSS license blocks might request and receive a temporary assignment from a multi-purpose spectrum block to temporarily supplement the network provider's spectrum capacity in a particular cell site in order to provide more capacity to an active UAS operation in that cell. We seek comment on our proposals and on alternatives.

17. We specifically propose to dedicate at least 10 megahertz of spectrum for NNA operations, and seek comment on this proposal. AIA and AURA support initially dedicating 10 megahertz for this purpose, and we find no support for dedicating less than 10 megahertz.⁴⁸ AIA argues that 10 megahertz will be sufficient to promote deployment while preserving the opportunity for an incremental approach to licensing the band that will better accommodate developing industry standards.⁴⁹ We seek comment on AIA's argument. We seek comment on the placement of the NNA spectrum within the band and whether, consistent with AIA's proposal, we should place 5 megahertz blocks at the bottom (5030-5035 MHz) and top (5086-5091 MHz) of the band for NNA use. Alternatively, should we locate the dedicated NNA blocks somewhere internal in the band rather than at the band edges? If so, should we designate the spectrum at the edges of the band for NSS?

18. An analysis by RTCA based in part on the use of an "online filter-design tool" finds that filters that sufficiently protect services in the adjacent bands "would necessitate guardbands unusable by terrestrial CNPC at both ends of the 5030-5091 MHz bands, reducing the 61 MHz of usable passband width to 42-52 MHz depending on the case."⁵⁰ It further states, however, that "[c]ustom filter designs could probably provide larger usable passbands than those obtained using the online tool, possibly at the cost of increased size and weight."⁵¹ We seek comment on this analysis, and whether fixed guard bands at one or both ends of the band are warranted to protect services in the spectrum adjacent to the 5030-5091 MHz band, including (1) radionavigation-satellite service (RNSS) downlinks in the 5010-5030 MHz band, (2) aeronautical mobile telemetry (AMT) downlinks to support flight testing in the 5091-5150 MHz band, and (3) the Aeronautical Mobile Airport Communications System (AeroMACS) in the 5000-5030 MHz and 5091-5150 MHz bands. Alternatively, does the need to protect adjacent band services argue for dedicating the edge spectrum to something other than NNA assignments, such as satellite?⁵² Below, we discuss more generally whether any measures beyond appropriate power and out-of-band-emissions limits are needed to protect these adjacent band services.

19. We further seek comment on whether, instead of designating separate upper and lower NNA blocks, we should place all dedicated NNA spectrum together in one contiguous block. Is placement of the NNA spectrum into two or more separate blocks useful for technical or other reasons? Conversely, would providing the spectrum in a single contiguous block reduce interference challenges (e.g., by potentially reducing the adjacency of NNA and NSS blocks) or better support certain channelizations of the band or important use cases that may require channel bandwidths of more than 5 megahertz? Further, with regard to any technical standards that commenters may recommend applying to

⁴⁸ See, e.g., AIA *Refresh PN* Comments at 17; AURA *Refresh PN* Comments at 6.

⁴⁹ See AIA *Refresh PN* Comments at 7-8; see also AURA *Refresh PN* Comments at 8 (asserting that 10 megahertz will "accomplish the Commission's goal of effectively promoting deployment").

⁵⁰ RTCA DO-362A, Appx. T at T.5, T.6.

⁵¹ *Id.* at T.6.

⁵² For example, in its analysis, RTCA asserts that although any guard bands at the edge of the 5030-5091 MHz band "would be unusable by terrestrial CNPC links, they could still be used by satellite-based CNPC if a satellite system is built to take advantage of the AMS(R)S allocation." *Id.* at T.1. We further discuss the protection of adjacent-band services below.

services or equipment in the 5030-5091 MHz band, we seek comment on whether these standards require the use of contiguous spectrum.⁵³

20. With regard to the remaining spectrum in the band, we seek comment on how to structure it consistent with the goal of dedicating a segment of spectrum for exclusive use NSS licenses. We seek comment on how much of the spectrum to dedicate for NSS operations, and how we should license any remaining spectrum. For the spectrum that we dedicate to NSS operations, we seek comment on the placement of the NSS blocks and on the appropriate block size for NSS licenses to promote investment and competition and support the current and evolving bandwidth needs of NSS services.⁵⁴ In the current record, AIA proposes 5 to 10 megahertz blocks, and Wisk supports 10 megahertz blocks.⁵⁵ We seek comment on these options and on any other appropriate block sizes. Below, we seek comment on the appropriate scope of permissible services, including whether to restrict communications in the 5030-5091 MHz band to CNPC, or permit transmissions of other types of communications. What size spectrum blocks would be necessary to support CNPC services? What block size would be appropriate if we permit NSS licensees to support non-CNPC communications? Would the flexibility of larger block sizes (such as 10 or 20 megahertz) better facilitate mixed CNPC and non-CNPC use?

21. While we anticipate that a significant portion of this remaining spectrum would be designated for NSS, we seek comment on whether we should use a portion of the spectrum for opportunistic use by both NNA or NSS licensees (multi-purpose use). Should we instead use a portion of the spectrum to increase the amount of spectrum dedicated to NNA operations? To the extent we dedicate spectrum for NSS licenses, we also seek comment on making that spectrum available for NNA operations on an interim, opportunistic basis. Under this approach, NNA users, in addition to having access to dedicated NNA spectrum, could use frequencies in a dedicated NSS block in geographic areas where the NSS licensee has not yet deployed an operating network. Once a network is deployed and operational in a particular area, NNA users would no longer have opportunistic access to the spectrum in that area. This approach would enable the NSS spectrum in an area to be used productively prior to the issuance of NSS licenses and deployment of networks, while providing NSS licensees with complete exclusivity once their systems are deployed. We seek comment on the costs and benefits of this approach, including its technical and economic feasibility, and on alternative approaches to NNA opportunistic access or alternative methods of ensuring productive usage of dedicated NSS spectrum prior to network deployment.

22. With these issues and questions in mind, we seek comment broadly on an appropriate band plan for the 5030-5091 MHz band. As one possible option for structuring the band overall, we invite comment on:

- Dedicating 10 megahertz of spectrum for NNA operations, with 5 megahertz blocks at the bottom (5030-5035 MHz) and top (5086-5091 MHz) of the band.
- Dedicating 40 megahertz of spectrum for NSS operations, divided into 4 licensed blocks of 10 megahertz each, with NNA opportunistic access as described above.

⁵³ For example, L3H asserts that RTCA DO-362 requires CNPC uplinks or downlinks to operate within a contiguous channel. *See* L3H *Refresh PN* Comments at 15.

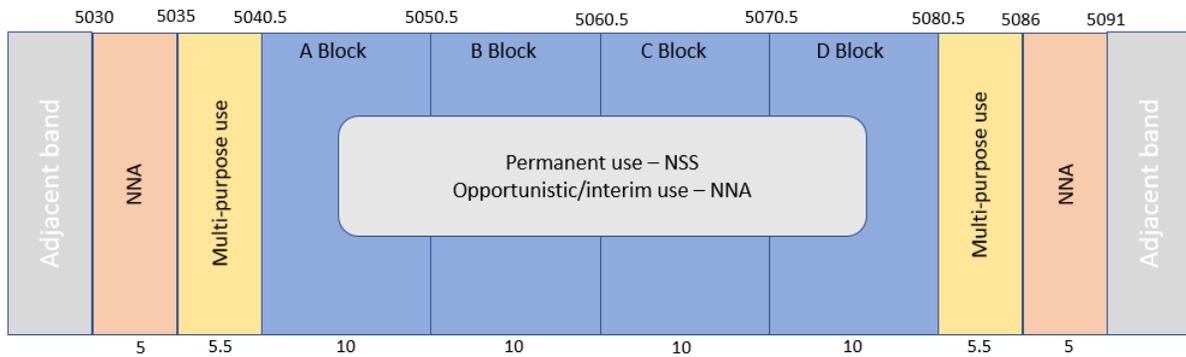
⁵⁴ *See, e.g.,* AIA *Refresh PN* Comments at 17 (arguing that frequency band partitioning and channelization schemes should not impede future use of the spectrum by advanced radio technologies).

⁵⁵ *See* AIA *Refresh PN* Comments at 17 (asserting that a 5 megahertz block is sufficient to permit a provider to serve a decent-sized market and provide operational experience controlling out-of-band emissions and in-band interference); AURA *Refresh PN* Comments at 8-9 (recommending blocks of at least five megahertz to provide “the industry with sufficient bandwidth to tailor internal network requirements and to safely serve a variety of UAS use cases”); Wisk *Refresh PN* Comments at 6 (supporting 10 megahertz blocks); *see also* Qualcomm *Refresh PN* Comments at 2 (proposing that, for the “network mode” of UAS communications, the Commission license either four 10.25 megahertz blocks or two 20.5 megahertz blocks).

- Making the remaining 11 megahertz available for temporary, opportunistic use by either NNA users or NSS licensees (multi-purpose use).

This potential option is illustrated in Figure 1; however, we seek comment on alternative band plans including plans that designate the edge spectrum for some purpose other than NNA operations (such as for NSS operations) or that provide different amounts of spectrum for NNA, NSS, and/or multi-purpose use than those presented in the depicted example.

Figure 1. UAS 5030-5091 MHz Band Plan



23. We further invite comment on alternative approaches to allocating the 5030-5091 MHz band for the support of UAS. For example, AIA proposes that we allocate and license the 51 megahertz between 5035 MHz and 5086 MHz on a geographic area basis in a phased, incremental manner over a period of years—e.g., allocating and licensing only 5 megahertz in the first year, and then licensing additional spectrum over the following years with blocks and geographic areas sized according to user demand and service provider applications.⁵⁶ AIA suggests that such an incremental approach would help the Commission to accommodate different UAS markets defined by different UAS missions that are expected to emerge over time.⁵⁷ We seek comment on this possible approach, and more generally on whether we should allocate only a portion of the band at this time and defer allocation of the remainder of the band. We further seek comment on whether we should preserve part of the band at this time for experimental use, or for potential future satellite-based CNPC that relies on the AMS(R)S allocation in the band.

24. As another alternative, Qualcomm recommends that the Commission allocate 20 megahertz for direct UA-to-UA communications, including communications between the aircraft to facilitate detect and avoid (DAA) operations, and communications to broadcast Remote ID information.⁵⁸

⁵⁶ See Letter from Karina Perez Molina, Director, Unmanned and Emerging Aviation Technologies, Aerospace Industries Association, to Marlene Dortch, Secretary, FCC, RM-11798 (filed Feb. 1, 2022) (AIA Feb. 1, 2022 *Ex Parte*) (filing notice of presentation to Ethan Lucarelli), Attach. at 6-7.

⁵⁷ See Letter from Karina Perez, Director, Unmanned and Emerging Aviation Technologies, Aerospace Industries Association, to Marlene Dortch, Secretary, FCC, RM-11798 (filed Sept. 14, 2021) (AIA Sept. 14, 2021 *Ex Parte*), at 1; AIA Feb. 1, 2022 *Ex Parte*, Attach. at 6-7 (arguing that “[a] phased implementation preserves large sections of the band for future licensing or use,” with the opportunity to open the band to new uses and updated technologies and standards).

⁵⁸ See Qualcomm *Refresh PN* Comments at 1. DAA involves a range of still-developing technologies to enable UAS or their operators to detect other aircraft or property and avoid collisions. See, e.g., S. Ramasamy & R. Sa batini, *A Novel Approach to Cooperative and Non-Cooperative RPAS Detect-and-Avoid*, SAE Technical Paper 2015-01-2470, 1 (Sept. 15, 2015), available at <https://www.sae.org/publications/technical-papers/content/2015-01-2470/> (last visited Sept. 6, 2022). DAA can rely on transmissions in a variety of ground-based or aircraft-based

(continued....)

Qualcomm proposes that the remaining 41 megahertz of spectrum be licensed in two 20.5 megahertz blocks or four 10.25 megahertz blocks to network providers for the provision of NSS CNPC services and for payload transmissions to the extent that capacity is not needed for CNPC.⁵⁹ We seek comment on this option and on Qualcomm's assertion that supporting the functionalities of DAA and Remote ID broadcasts will require 20 megahertz of 5030-5091 MHz band spectrum.⁶⁰ We also seek comment on the compatibility of UA-to-UA transmissions and UA broadcast with CNPC links between a ground control station and a UA. If they are not compatible, should a portion of the band be designated exclusively for UA-to-UA or UA broadcast transmissions, and if so, how much spectrum should be designated for this purpose?⁶¹

25. We seek comment on whether we should establish any internal guard bands, such as between the NNA and NSS blocks, or whether we can rely on appropriate technical rules to ensure that UAS operations in one block do not cause harmful interference to UAS operations in adjacent spectrum blocks. We request that parties proposing guard bands provide detailed technical justification and specify the width and placement of the proposed guard bands. We further seek comment on whether fixed guard bands at one or both ends of the band are warranted to protect services in the spectrum adjacent to the 5030-5091 MHz band, including (1) radionavigation-satellite service (RNSS) downlinks in the 5010-5030 MHz band, (2) aeronautical mobile telemetry (AMT) downlinks to support flight testing in the 5091-5150 MHz band, and (3) the Aeronautical Mobile Airport Communications System (AeroMACS) in the 5000-5030 MHz and 5091-5150 MHz bands. Below, we discuss more generally whether any measures beyond appropriate power and out-of-band-emissions limits are needed to protect these adjacent band services.

2. Dynamic Frequency Management System

26. To address the complexities involved in coordinating shared interference-protected access to the 5030-5091 MHz band, we propose that access to the band be managed by one or more dynamic frequency management systems (DFMS). We use the term DFMS to describe a frequency coordination system that, in response to requests from UAS operators for frequency assignments in NNA spectrum, would determine and assign to the requesting operator, through an automated (non-manual) process, temporary use of certain frequencies for a particular geographic area and time period tailored to the operator's submitted flight plan. For the duration of the assignment, the operator would have exclusive and protected use of the assigned frequencies within the assigned area and timeframe, after which the frequencies would be available in that area for assignment to another operator. We contemplate that each DFMS would be administered by a private third party, which we refer to as a DFMS administrator. We further contemplate that each system would be capable of coordination-related activities across the entire 5030-5091 MHz band. While we contemplate that NSS licensees would be responsible for the use and coordination of frequencies within the scope of their licenses, requiring a

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implementations, for example non-cooperative detection methods such as on-board sensors or cooperative methods that involve the communication between UAS to facilitate cooperative collision avoidance. *See id.* Remote ID, as required by FAA rules that became effective on April 21, 2021, is the ability of UAS in flight to broadcast identification and location information that can be received by other parties. *See* FAA, *UAS Remote Identification*, https://www.faa.gov/uas/getting_started/remote_id/ (last visited Sept. 6, 2022). We note that FAA rules currently require Remote ID to be broadcast using devices authorized under the Commission's part 15 rules. *See* 14 CFR § 89.320(g).

⁵⁹ *See* Qualcomm *Refresh PN* Comments at 2.

⁶⁰ *See* Qualcomm *Refresh PN* Comments at 8 (asserting that 20 megahertz will be needed for "broadcasting of detection information by UAVs for 'remain well clear' messaging and collision avoidance, [broadcast Remote ID], and potentially other important safety and security use cases").

⁶¹ *See, e.g.,* AIA Feb. 1, 2022 *Ex Parte*, Attach. at 5, 7 (suggesting that allocating some portion of the band for UAS vehicle-to-vehicle (V2V) communications would "provide situational awareness for UAS that cannot use ADS-B due to the Remote ID (RID) rule" but that 20 megahertz for V2V would be "an oversupply").

DFMS to be capable of coordination across the entire band would enable a DFMS to provide dynamic access to any portions of the 5030-5091 MHz band that are, in the initial order or subsequently, assigned for NNA use, as well as to implement opportunistic access to portions of the band that are assigned for NSS use as appropriate. We tentatively conclude that these systems could (1) facilitate the efficient and intensive use of a limited spectrum resource for interference-protected CNPC; (2) give UAS operators access to reliable CNPC for operations where those communications links are safety-critical; (3) enable UAS operators to gain spectrum access in a timely, efficient, and cost-effective manner; (4) enforce compliance with frequency assignments through access controls, checking existing frequency assignments, providing updates in authorized databases, and other mechanisms; (5) protect critical communications inside the band and in adjacent spectrum; (6) support opportunistic use in unused portions of spectrum sub-bands designated for exclusive use licenses; and (7) promote rapid evolution of the use of the band in response to technological, market, or regulatory changes, such as if the Commission deploys spectrum in the band incrementally or, in the future, finds that modifying the access rules in a particular sub-band is in the public interest to better meet market demand. We seek comment on our proposal and its costs and benefits.

27. The record and past Commission experience further lead us to tentatively conclude that the DFMS approach we propose is feasible and practical. The record reflects support from a number of parties for the use of such a system to manage shared access to the 5030-5091 MHz band.⁶² In addition, the Commission has successfully relied on automated dynamic frequency management systems in other bands, including the Spectrum Access System (SAS) that was adopted in the 3.55-3.7 GHz band (3.5 GHz band) to coordinate spectrum access to the Citizens Broadband Radio Service (CBRS), allowing incumbent radar systems, licensed services, and licensed-by-rule services to coexist in the band.⁶³ Several parties in the record state that aspects of the SAS can be leveraged or incorporated in the development and deployment of a DFMS.⁶⁴ The support in the current record for the use of a DFMS, along with the success of the 3.5 GHz band SAS and the potential to build on the SAS experience and technology, lead us to tentatively conclude that a DFMS solution can feasibly be implemented to enable near-term use of the band with the benefits discussed above. We seek comment on our tentative conclusion, and the extent of interest in providing such DFMS services in the 5030-5091 MHz band. In addition to the specific questions below, what other aspects of the 3.5 GHz band SAS approach would be appropriate here, and what aspects should be changed? How should the Commission supervise the operations of the DFMS?

28. We propose to permit more than one DFMS to operate in the band, each providing access to frequencies nationwide, and to require coordination and communication between them to ensure that the assignments of one DFMS are consistent with the assignments of the others. This approach would provide the benefits of competition to DFMS services, including promoting technological innovation in such services, encouraging responsiveness to market demands through tailored and differentiated services, helping to prevent discriminatory conduct based on potential conflicts of interest, and placing competitive pressure on fees and service quality.⁶⁵ Further, the use of multiple competitive administrators

⁶² See *AIA Refresh PN* Comments at 4, 7; *AURA Refresh PN* Comments at 8; *Boeing Refresh PN* Comments at 5; *DSA Refresh PN* Comments at 3; *Federated Wireless Refresh PN* Comments at 2-3; *FPL Refresh PN* Comments at 4; *L3H Refresh PN* Comments at 3; *WInnForum Refresh PN* Comments at 3-4; *Wisk Refresh PN* Comments at 3; *Xcel Refresh PN* Reply at 5.

⁶³ See 47 CFR pt. 96; see also, generally, *Amendment of the Commission's Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, GN Docket No. 12-354, Report and Order and Second Further Notice of Proposed Rulemaking, 30 FCC Rcd 3959 (2015) (*3.5 GHz R&O*).

⁶⁴ See *DSA Refresh PN* Comments at 2-3; *Federated Wireless Refresh PN* Comments at 3-7; *WInnForum Refresh PN* Comments at 5; see also *AIA Refresh PN* Comments at 8 (stating that the SAS as used in the 3.5 GHz band does not meet all the requirements for a aviation use, having been designed for use by fixed, ground-based networks, but finding that some aspects of the concept could be incorporated).

⁶⁵ See, e.g., *3.5 GHz R&O*, 30 FCC Rcd at 4063-64, 4066, paras. 354, 357, 366.

was successfully implemented in the 3.5 GHz band, where the Commission has, to date, authorized six SASs for full commercial operations in the band.⁶⁶ We seek comment on this proposal.

29. *DFMS requirements and responsibilities.* We seek comment on the appropriate regulatory framework to establish for a DFMS, including its requirements and responsibilities and the requirements and responsibilities of a DFMS administrator. We seek comment on whether and to what extent we can draw on the requirements and responsibilities governing the SAS and SAS administrators in the 3.5 GHz band.⁶⁷ For example, we seek comment on whether to follow our policy for the 3.5 GHz SASs and establish only the minimum high-level requirements necessary to ensure the effective development and operation of fully functional DFMSs, leaving other requirements to be addressed by the DFMS administrators and multi-stakeholder groups.⁶⁸ If we follow this policy, what high-level requirements should we establish? Below, we explore in greater detail a potential regulatory framework for DFMSs, and the extent to which aspects of the DFMS requirements and operation should be specified in our rules.

30. One of the most important responsibilities of the DFMS would be to ensure that UAS operators receiving 5030-5091 MHz assignments and operating consistent with their assignments are protected from harmful interference and that they do not cause harmful interference to other protected operations in the band and adjacent bands, including protected federal operations.⁶⁹ In light of the many challenges of ensuring appropriate protection and reliability for all authorized UAS operations in the band, which could involve highly diverse and evolving operations with different risk profiles, altitudes, flight speeds, and spectrum needs in a shared spectrum environment, and could potentially involve the need for mid-flight alterations to flight plans and other operational complications, we seek comment on whether the Commission should simply establish an appropriate high-level requirement on the DFMS, such as a requirement to provide protected access to spectrum appropriate to cover a submitted and valid request, to the extent such spectrum is available, and defer to the DFMS administrators, or potentially a multi-stakeholder group, to determine the appropriate means of doing so. To the extent the Commission should codify more detailed requirements, we seek comment on all measures the Commission should adopt to facilitate the ability of the DFMS to provide reliable, interference-protected assignments,

⁶⁶ *Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Four Spectrum Access System Administrators for Full Scale Commercial Deployment in the 3.5 GHz Band and Emphasize Licensee Compliance Obligations in the 3650-3700 MHz Band Under Part 96*, GN Docket No. 15-319, Public Notice, 35 FCC Rcd 117, 117, para. 1 (WTB/OET 2020) (certifying CommScope, Federated Wireless, Inc., Google, and Sony, Inc. as SAS Administrators); *Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Spectrum Access System Administrator Amdocs for Full Scale Commercial Deployment in the 3.5 GHz Band*, GN Docket No. 15-319, Public Notice, 35 FCC Rcd 3687, 3687, para. 1 (2020 WTB/OET) (certifying Amdocs, Inc. as a SAS Administrator); *Wireless Telecommunications Bureau and Office of Engineering and Technology Approve Spectrum Access System Administrator Key Bridge Wireless for Full Scale Commercial Deployment in the 3.5 GHz Band*, GN Docket No. 15-319, Public Notice, 36 FCC Rcd 4880, 4880, para. 1 (WTB/OET 2021) (certifying Key Bridge Wireless LLC as a SAS Administrator). On May 1, 2021, the Commission gave conditional approval to three additional parties as SAS Administrators, subject to further testing and review before final certification. See *Wireless Telecommunications Bureau and Office of Engineering and Technology Conditionally Approve Three Spectrum Access System Administrators for the 3.5 GHz Band*, GN Docket Nos. 17-258, 15-319, Public Notice, 36 FCC Rcd 8255 (WTB/OET 2021) (conditionally approving Fair Spectrum LLC, Nokia, and RED Technologies). See also, e.g., *DSA Refresh PN Comments at 5* (recommending that the Commission “continue its policy of authorizing multiple commercial dynamic spectrum management system administrators,” and asserting that competition among these providers “will spur greater innovation and reduce costs”).

⁶⁷ See 47 CFR pt. 96 subpt. F (Spectrum Access System); see also *3.5 GHz R&O*, 30 FCC Rcd at § III.H.

⁶⁸ We discuss a potential role for a multi-stakeholder group in greater detail below.

⁶⁹ See *infra* Section II.B.9 (seeking comment on measures necessary to protect federal Microwave Landing Systems in the 5030-5091 MHz band and various out-of-band services).

including any necessary specifications, requirements, responsibilities, authority, processes, or remedies. We further seek comment on the interference mitigation techniques that can be employed by UAs, such as geo-fencing.⁷⁰

31. At a minimum, we propose to require that a DFMS administrator adopt procedures to immediately respond to requests from Commission staff for information they store or maintain and to comply with any Commission enforcement instructions they receive, as well as to securely transfer all the information in the DFMS to another approved entity in the event it does not continue as the DFMS Administrator at the end of its term. We seek comment on these proposals. In addition, what requirements should we impose on the DFMS or DFMS administrator with regard to retention of records and information, including registration and assignment records? Should we require retention of all such information for at least five years? What requirements should we adopt to ensure data security in DFMS operations, including the security of end-to-end communications between operators and a DFMS and the security of information stored by a DFMS?

32. What requirements, if any, should be imposed on NNA operators in the band to help ensure the DFMS's ability to provide interference-protected access or to promote more robust or efficient use of the spectrum? Should these requirements be high-level, with additional development through a DFMS administrator or multi-stakeholder group, or should they be more detailed? What information should we require operators to provide to the DFMS regarding ground stations and unmanned aircraft stations? Should that information be provided prior to any requests, with an assignment request, or on an ongoing or periodic basis during an operation? For example, should we require operators to provide ground station geographic location, effective isotropically radiated power (EIRP), and/or antenna patterns? Assuming a DFMS has the necessary information about the ground station, is information about the location or transmitter characteristics of the UA unnecessary to prevent harmful interference? Should we require an active UAS relying on an NNA assignment in the band to provide a DFMS with the UA information that must be broadcast under the Remote ID rule or some subset or variation of that information?⁷¹ Should an operator be required to provide the DFMS specific information about the UA, including its manufacturer, model, or other technical or identifying information? Should an operator be required to affirmatively communicate to the DFMS, in real time or within a certain period of time of the relevant event, the initiation and termination of the flight or, alternatively, the initiation and termination of the operator's use of the assigned frequencies? Are there other circumstances or information (aside from the request) that the operator should be required by rule to communicate to the DFMS? Should any requirements be imposed on UAS operators relying on NSS networks to facilitate the DFMS's ability to provide interference-protected NNA assignments?

33. We further seek comment on whether to mandate that a UAS operator register with a DFMS as a precondition to requesting NNA frequency assignments, and if so, what requirements we should impose with respect to such registration. Should the Commission simply require registration and leave the details to be developed by, for example, the DFMS administrators or a multi-stakeholder group? To the extent the Commission should codify further details, what information should be included with registration? Should UAS operators be required to register ground and UA stations? Should we impose requirements with regard to if and when registration should be updated and, if so, what is the appropriate duration of the initial registration term and the renewal term? Under what circumstances should the Commission or the relevant DFMS administrator revoke a UA operator's registration? While we

⁷⁰ Geo-fencing is a technique of defining a virtual geographic boundary (defined by coordinates) around an area. Depending on the implementation, when a UA approaches the boundary, the UA or its controller could receive a transmission to change course to avoid the area.

⁷¹ The FAA's rules for Remote ID require most UAS operating in United States airspace to have Remote ID capability. See *Remote ID Rules* at 4403-04; 49 CFR § 89.101. Remote ID capability includes the broadcast of information such as the identity, location, and altitude of a drone in flight, including its control station or take-off location. See 14 CFR § 89.305.

envision that any registration requirements would apply only to operators seeking NNA assignments, we seek comment on whether to require operators relying on a network service in NSS spectrum to register with a DFMS.

34. We also seek comment on what requirements, if any, we should impose with respect to the submission of UAS operator requests for NNA assignments, and conversely what, if any, details of the request process should be left to be developed by a multi-stakeholder group. For example, should we impose specifications of what information should be included in a request, and if so, what data should we require? Should requests include the relevant ground and unmanned aircraft stations that will be used in the operation, and if so, how should these be identified? To the extent we permit mobile ground stations, should requests provide a specification of the route of the mobile ground station over time and the times at which the station will reach specific locations in order to enable frequency assignment to consider the range coverage of the station as a function of time? Should we require submission of a flight plan, and if so, what information should the flight plan include, and in what format? For example, should it specify time of use, and flight positions and flight altitude over the course of the flight plan, as suggested by AIA?⁷² Should an operator be required to submit requests no more than a certain specified time period in advance of a flight?⁷³

35. As a general matter, should a DFMS grant a frequency assignment for the duration and other parameters requested, provided the unassigned spectrum is available to meet the request? Alternatively, should limits or restrictions be placed on what can be granted? For example, should a limit be placed on the maximum duration of an assignment to prevent monopolization of the spectrum by one or a few parties with flights of long or indefinite duration?⁷⁴ Should a limit be placed on the number of simultaneous temporary frequency assignments allowed by the DFMS to reduce the potential for harmful interference?

36. As several parties have noted, operators may need to revise their assignments after a flight has commenced (e.g., where the flight needs to deviate from its anticipated flight path and UAS CNPC transmissions for the revised flight would not be covered by the original assignment, or where a flight takes longer than provided under the assignment). We seek comment on any rules we should adopt to enable or facilitate the filing and timely processing of such requests for revised assignments or to otherwise address an operator's mid-flight need for revised assignment. Do we need to adopt any rule to address cases where the revised request cannot be granted consistent with other previously granted assignments?

37. In the 3.5 GHz band, SASs may require fixed stations to implement reassignment to new frequencies, reduction of the permitted transmitting power level, or cessation of operations, as necessary to avoid or eliminate harmful interference and implement spectrum access priorities.⁷⁵ We note, however, that the 5030-5091 MHz band presents challenges to such an approach that are not present in the 3.5 GHz band. First, whereas the 3.5 GHz stations under SAS control are all fixed stations (i.e., stations operating from a fixed location), facilitating a SAS's ability to communicate with such stations and determine their location, we seek comment below on permitting UAS ground stations in the NNA portion of the 5030-5091 MHz band to be mobile stations (e.g., hand-held controllers).⁷⁶ Second, active management of

⁷² See AIA *Refresh PN* Comments at 9.

⁷³ See AIA Petition at 14 (indicating that RTCA DO-362 “anticipates” that requests will be made no more than 20 minutes in advance of a flight). *But see* RTCA *Refresh PN* Comments at 4 (stating that “[i]n some circumstances, requests for channel assignments for flights could be made days in advance”).

⁷⁴ See, e.g., dronelife, *Heavy Lift Tethered Drone Flies for a Week: Zenith AeroTech Celebrates 108 Hours of Uninterrupted Flight*, <https://dronelife.com/2021/06/10/heavy-lift-tethered-drone-flies-for-a-week-zenith-aerotech-celebrates-108-hours-of-uninterrupted-flight/> (last visited Sept. 6, 2022).

⁷⁵ See 47 CFR § 96.39(c)(2).

⁷⁶ See *infra* para. 58 & n.112.

spectrum access during an ongoing UAS operation could introduce significant safety hazards, such as if a DFMS were to require automatic cessation or powering-down of a UAS CNPC link while a flight was ongoing, resulting in a mid-operation loss of control.⁷⁷ Given such challenges, is an active management approach feasible and appropriate, and if so, what regulatory requirements should be adopted to enable or implement such an approach? If not feasible, what approaches or mechanisms will be available to the DFMS to ensure the reliability of communications? In particular, given that the proposed assignments would be limited in both frequency, time, and geography, what requirements, procedures, penalties, or other measures should be in place to prevent or address (1) flights that use unauthorized frequencies; (2) flights that occur outside an authorized time period, such as a flight that exceeds its authorized duration; or (3) flights that occur outside an authorized area. If a DFMS's role is merely to reserve appropriate spectrum for UAS flights, and a DFMS takes no other active measures to ensure or enforce compliance with the assignments or the protection of operations, will spectrum access be sufficiently reliable for mission critical purposes?

38. *Fees.* Under the 3.5 GHz rules, an SAS administrator is authorized to charge users “a reasonable fee” for the provision of its services, and the Commission “can require changes to those fees if they are found to be unreasonable.”⁷⁸ We propose to adopt a similar provision authorizing the administrator of a DFMS to charge reasonable fees for its provision of services, including registration and channel assignment services, and to permit parties to petition the Commission to review fees and require changes if they are found to be excessive. To encourage efficient use of the limited spectrum resource and discourage any attempt at warehousing, we seek comment on specifically authorizing reasonable usage-based fees, and on standards and approaches for establishing the amounts of such fees.

39. *Selection process.* We seek comment on the process for selecting the DFMS administrators, and whether the 3.5 GHz SAS approval process could serve as a model.⁷⁹ Under the approach for SAS approval, the Commission delegated authority to WTB and OET to administer the process and provided that (1) the Bureaus would issue a Public Notice requesting proposals from entities desiring to administer a SAS; (2) applicants would be required, at a minimum, to demonstrate how they plan to meet the Commission's rules governing SAS operations, demonstrate their technical qualifications to operate a SAS, and provide any additional information requested by WTB and OET; (3) based on these applications, WTB and OET would determine whether to conditionally approve any of the applicants; and (4) any applicants that received conditional approval would be required to demonstrate that their SASs meet all the requirements in the rules and any other conditions the Bureaus deemed necessary, and at a minimum, to allow their systems to be tested and analyzed by Commission staff.⁸⁰ We seek comment on

⁷⁷ For this reason, some parties in the record oppose mechanisms that would automatically revoke an assignment after the duration of assignment has expired. See *EEI Refresh PN* Comments at 8 (“Frequency assignments should not be revoked during flights because it would create potential safety concerns.”); *L3H Refresh PN* Comments at 5-6 (suggesting that use of an assignment beyond its duration should be subject to post-flight investigation and enforcement, but that “[r]evocation of a frequency channel should never occur during a UAS flight”). But see *RTCA Refresh PN* Comments at 5 (stating that automatic revocation of an assignment without confirmation from the UAS operator “should happen only after the frequency assignment manager has followed documented, disclosed and agreed upon . . . safety procedures”).

⁷⁸ See 47 CFR § 96.65(a), (b).

⁷⁹ See *3.5 GHz R&O*, 30 FCC Rcd at 4067, paras. 369-73; see also, e.g., *Wireless Telecommunications Bureau and Office of Engineering and Technology Conditionally Approve Seven Spectrum Access System Administrators for the 3.5 GHz Band*, GN Docket No. 15-319, Public Notice, 31 FCC Rcd 13355, 13356-59, paras. 7-10 (WTB/OET 2016).

⁸⁰ See *3.5 GHz R&O*, 30 FCC Rcd at 4067, paras. 371-72; see also 47 CFR §§ 0.241(j), 0.331(f) (jointly delegating to the Chiefs of OET and WTB authority to administer the SAS and SAS Administrator functions, and “to develop specific methods that will be used to designate SAS Administrators; to designate SAS Administrators; to develop procedures that these SAS Administrators will use to ensure compliance with the requirements for SAS operation; to

(continued....)

adopting this approach. In particular, we seek comment on facilitating the potential selection of multiple DFMSs through an application and certification process by which any entity found to meet the requirements can be the administrator of such a system, and we seek comment on what eligibility requirements should be set and whether (or to what extent) they should be codified or established through a separate process. We also seek comment on whether we should provide a testing or trial phase for DFMS technology prior to the submission of applications, to facilitate or inform the requirements of the application process. Following the SAS model, we propose to delegate jointly to WTB and OET the authority to administer the selection process and make the selection. We seek comment on what role the FAA and NTIA should have in setting up the process, reviewing applications, and making the selection.

40. *Coordination with flight authorization.* In addition to spectrum access, i.e., authorization to transmit, UAS operators also need approved or otherwise authorized access from the FAA to conduct flights in the airspace of the United States. For example, under part 107, UAS operators are authorized to fly in uncontrolled airspace below 400 feet above the ground (AGL) and in accordance with part 107 of the FAA's rules without specific airspace authorization, whereas part 107 flights in controlled airspace generally require a specific airspace authorization from air traffic control.⁸¹ Under the UAS Traffic Management (UTM) program, however, the FAA has been developing a separate ecosystem of requirements, services, and other features to enable the traffic management of low-altitude UAS operations, including systems for automating the flight approval process.⁸² One result of the program has been the deployment of the Low Altitude Authorization and Notification Capability (LAANC) system, through which UAS operators can apply to LAANC service providers to receive a near real-time airspace authorization for operations under 400 feet in controlled airspace around airports.⁸³

41. We seek comment on whether and how frequency assignments should be coordinated with airspace authorization for low altitude, high altitude, and terminal (departure/arrival) operations. For example, should a DFMS be required to determine that a requesting party has any necessary flight authority as a condition of granting a spectrum assignment request? If so, we seek comment as to whether and how a DFMS would interact with air traffic control or the relevant UTM systems (such as LAANC), or otherwise obtain information regarding airspace approvals, authorizations, or availability.

42. *Alternative approaches to dynamic spectrum access.* We seek comment on other options to enable dynamic spectrum access to the 5030-5091 MHz band. Some parties suggest that we adopt some form of cognitive radio solution, in which UAS radios would directly detect and identify available spectrum channels.⁸⁴ They argue that a centralized system like the DFMS will be complex and labor intensive to use, will be inefficient in spectrum assignments and vulnerable to spectrum warehousing, and will have difficulty ensuring link protection and responding quickly to developments such as changes in

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make determinations regarding the continued acceptability of individual SAS Administrators; and to perform other functions as needed for the administration of the SAS”).

⁸¹ See FAA, *Small Unmanned Aircraft Systems (UA) Regulations (Part 107)*, <https://www.faa.gov/newsroom/small-unmanned-aircraft-systems-uas-regulations-part-107> (last visited Sept. 6, 2022) (stating that part 107 “[o]perations in Class G airspace are allowed without air traffic control (ATC) permission” while such “[o]perations in Class B, C, D and E airspace need ATC authorization.”).

⁸² See FAA, *Unmanned Aircraft System Traffic Management*, https://www.faa.gov/uas/research_development/traffic_management (last visited Sept. 6, 2022); see also NASA, *Aeronautics Research*, <https://www.nasa.gov/utm> (last visited Sept. 6, 2022).

⁸³ See FAA, *UAS Data Exchange (LAANC)*, https://www.faa.gov/uas/programs_partnerships/data_exchange/ (last visited Sept. 6, 2022).

⁸⁴ See L3H *Refresh PN* Comments at 13 (asserting that cognitive radios would have benefits and are “worthy of further consideration”); SSC *Refresh PN* Comments at 4-5 (proposing a system including “multiple types of evidence” to determine a availability including database query and optional device-based sensing).

flight plans while a UA is already in flight.⁸⁵ We seek comment on these concerns and whether they can be addressed by a DFMS, and we seek comment on the feasibility, costs, and benefits of alternative options as compared to the DFMS discussed above, and whether such alternatives would be sufficiently reliable to support even the most safety-critical uses such as flights in controlled airspace. We further seek comment on whether there are existing technologies that could be applied or adapted to implement these alternative approaches, and on any standards work or other studies regarding the safety and reliability of links under such systems.

43. We note that the Commission has, in two cases, adopted a variation of the DFMS approach in which, for a particular device to access the relevant spectrum band, automated and periodic queries of spectrum availability are made to a central database by the device itself. In the 6 GHz band, the Commission adopted a system that allows unlicensed access to temporarily unused portions of the band while protecting incumbent services through a database of incumbent operations that certain unlicensed devices must query to determine available channels for their coverage area.⁸⁶ Similarly, in the TV bands, the Commission established a TV white space database that is queried by an unlicensed device seeking access to the bands and that authorizes operations only on unused spectrum throughout the unlicensed device's coverage area.⁸⁷ We seek comment on whether a similar system could be adopted for NNA operations in the 5030-5091 MHz band, under which 5030-5091 MHz radios would be required to directly and periodically query a central database for available channels. Given that the 6 GHz and white space systems are implemented to enable unlicensed devices to access spectrum without interference protection, we seek comment on whether this type of system could be suitable to implement interference protection for UAS NNA operations. Could such a system be implemented in a manner that provides an assignment of protected spectrum that covers all applicable stations in a particular UAS NNA operation (e.g., both the operator's control station and the associated airborne radio) and ensures protected access for the duration of an entire UAS flight plan? Alternatively, could such a device query function be added to the DFMS as a second and optional means of receiving authorization from the DFMS for use cases where such authorization is sufficient? If the Commission adopts rules providing for the establishment of such a system, should we require that the system database be updated in real time with relevant parameters of the NNA systems currently in operation? We further seek comment on whether any such system and any tool used to perform the interference analysis should be certified and approved for use by the Commission and/or other appropriate authorities prior to operation.

44. In the event that we adopt rules providing for the establishment and operation of a DFMS or some other coordination system or process, there may be a significant period of time before such coordination system is operational in the band and some operators may want protected access to the band during this interim period. While such operators may currently apply for special temporary authority to use the band, these authorizations do not provide interference protection.⁸⁸ Accordingly, we seek comment on whether to establish some method by which operators can get temporary protected access to frequencies in the 5030-5091 MHz band, or a portion of the band, during this interim period. Should we provide that parties may apply during this period for licenses comparable to grants of part 5 special temporary authority (STA) (e.g., a duration of no more than 6 months) but with rights of interference

⁸⁵ See, e.g., SSC Refresh PN Comments at 9-11.

⁸⁶ See *Unlicensed Use of the 6 GHz Band et al.*, ET Docket No. 18-295, et al., Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 3852 (2020) (6 GHz R&O).

⁸⁷ See generally 47 CFR pt. 15, subpt. H. See also, generally, *Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 600 MHz Guard Bands and Duplex Gap and Duplex Gap, and Channel 37, et al.*, ET Docket No. 14-65, et al., Report and Order, 30 FCC Rcd 9551 (2015).

⁸⁸ See 47 CFR § 1.931(b)(1); *Promoting Expanded Opportunities for Radio Experimentation and Market Trials under Part 5 of the Commission's Rules and Streamlining Other Related Rules et al.*, ET Docket No. 10-236, et al., Report and Order, 28 FCC Rcd 758, 760, para. 3 (2013).

protection, and subject to pre-application coordination through a frequency coordinator group and to termination in the event a DFMS becomes operational? Should such uses have the same opportunity for renewal as part 5 STAs? Moreover, we seek comment on an interim frequency management process through which parties could obtain limited, short-term access to spectrum, such as access suitable for a single flight or event.

3. Multi-stakeholder Group

45. We seek comment on a possible role for a multi-stakeholder group to help develop the requirements and processes applicable to the DFMSs, as well as to study standards and interference issues associated with UAS operations in the band. There are aviation-specific considerations that may affect how spectrum access should be managed, and it may be beneficial for stakeholders versed in such considerations (e.g., members of the aviation industry, the UAS standards-making community, frequency managers, and network operators) to assist in the development of requirements and processes. In the context of the 3.5 GHz band, the Commission encouraged the informal creation of a multi-stakeholder group to develop various implementation details to facilitate development of CBRS, and this approach proved highly successful.⁸⁹ This informal reliance on multi-stakeholder group activities has been adopted in other contexts as well, including the implementation of Automated Frequency Coordination (AFC) systems in the 6 GHz band.⁹⁰ Further, several parties in the record support a role for a multi-stakeholder group to further develop requirements for the DFMS and the 5030-5091 MHz band, although some advocate the designation of a more formal, governing body to serve in this role.⁹¹ We seek comment on whether, consistent with the successful approach in the 3.5 GHz band, we should encourage a multi-stakeholder group to address implementation issues in the 5030-5091 MHz band, but without the Commission formally designating such a group or imposing a formal process for how the group reaches its determinations or recommendations. If such a multi-stakeholder group were to be formed by third parties, what selection procedures might be desirable to ensure that the group appropriately reflects the diversity of UAS stakeholders? What role might federal agency stakeholders have in this process? We

⁸⁹ See *3.5 GHz R&O*, 30 FCC Rcd at 4081, paras. 416, 417 (finding that a multi-stakeholder group could be instrumental in developing answers to some of the novel technical questions raised by the CBRS rules, declining to formally designate a group or adopt a specific process for reviewing and responding to their recommendations, but encouraging any such group to work to share their findings with the Commission and to incorporate their work, to the extent feasible, into the development of the 3.5 GHz band SAS and citizens band radio service devices). To serve as a multi-stakeholder group for this purpose, the Wireless Innovation Forum (WInnForum) created the Spectrum Sharing Committee, which, *inter alia*, collaborated with relevant government agencies to develop 10 standards for the 3.5 GHz band addressing a range of CBRS and SAS technical and operational issues. See, e.g., *WInnForum Refresh PN Comments* at 1-2.

⁹⁰ See *6 GHz R&O*, 35 FCC Rcd at 3918-19, paras. 174-80 (encouraging the formation of a multi-stakeholder group to provide a forum for the industry to study technical and operational issues raised by 6 GHz band unlicensed access and work cooperatively towards solutions); see also *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343, 2467, para. 333 (2020).

⁹¹ Compare *Federated Wireless Refresh PN Comments* at 7-8 (recommending that the Commission follow the approach taken in the 3.5 GHz band and rely on cross-industry stakeholder groups to develop consensus standards for the performance of a shared access system for the 5030-5091 MHz band), with *AIA Refresh PN Comments* at 13, 18 (recommending that the Commission and FAA jointly authorize an independent governing board to oversee the band), and *ASRI Refresh PN Comments* at 8 (supporting the establishment of a “governing body formed from the UAS user community with FAA and Commission participation to oversee the frequency management system”). See also *L3H Refresh PN Comments* at 2, 5-6 (proposing that the FCC and FAA collaborate with industry to establish a “UAS Spectrum Committee” responsible for establishing policies, procedures, and standards for assignment of frequencies and procedures for processing frequency requests, as well as policies and procedures for releasing channels following the end of flight). While AIA proposes establishment of a formal “governing body,” it also discusses a potential role for “standards development organizations” to determine standards for such matters as the returning of frequency assignments. See *AIA Refresh PN Comments* at 10, 13.

seek comment on these and any additional procedures or approaches that a multi-stakeholder group might implement, particularly in light of the positive experience with the 3.5 GHz band stakeholder group.

46. Assuming there is a role for a multi-stakeholder group, we seek comment on the appropriate extent of that role and the responsibilities it might most usefully undertake. We seek comment on the matters a multi-stakeholder group should address with consensus standards or other determinations, or with the development of recommendations to one or more of the stakeholder agencies. We further seek comment on the matters that the Commission should address independently of any multi-stakeholder group and the rules it should adopt to establish a basic regulatory framework to govern the 5030-5091 MHz band and the DFMSs.

4. Scope of Permissible Services

47. In considering the appropriate scope of services to permit in the band, we begin with the services permitted by the underlying allocation. As discussed above, the Commission added an AM(R)S allocation in the 5030-5091 MHz band to support UAS communications. AM(R)S is reserved exclusively for communications relating to the safety and regularity of flight, primarily along national or international civil air routes.⁹² Consistent with the scope of the allocation and the expressed purpose for its incorporation, we propose to permit only CNPC and to define CNPC as any UAS transmission that is sent to or from the UA component of the UAS and that supports the safety or regularity of the UA's flight.⁹³ We seek comment on these proposals and on alternatives that would be consistent with the allocation and its purpose. Should we alternatively define CNPC to cover any communications to or from a UA other than payload communications, and to define payload as information sent to achieve mission objectives?⁹⁴ RTCA DO-362A, which provides MOPS for UAS CNPC in the 5030-5091 MHz band, states that "payload communications," for purposes of the standard, "specifically include communications associated with the UA mission payloads, which do not contain safety-of-flight information," and clarifies that "[s]afety-of-flight information is any information/data sent to or received from the UA that is necessary to ensure the UAS is operated/operating in a manner that protects people and/or property from harm due to unintentional events."⁹⁵ We seek comment on whether to adopt these or similar terms to define the scope of permissible CNPC. NTIA proposes that we limit the band to a subset of CNPC, specifically communications for the control of the UA and other "safety-critical functions," in order to limit UAS use to "essential services."⁹⁶ RTCA DO-362A similarly provides that CNPC includes "[d]ata and information sent to/from the Pilot Station and the UA for the control of the UA and other safety-critical functions."⁹⁷ We seek comment on this option, on the costs and benefits of limiting the band to only the "safety-critical" communications, on what types of communications would be considered "safety-critical," and what, if any, types of non-payload but safety-related communications would not be considered "safety-critical." More generally, should we restrict communications to a subset of CNPC?

⁹² See 47 CFR §§ 2.1, 2.106.

⁹³ See ASRI *Refresh PN* Comments at 5-6 (arguing that band access should be dedicated to "UAS safety and regularity of flight communications"); AURA *Refresh PN* Comments at 6; Boeing *Refresh PN* Comments at 8; RTCA *Refresh PN* Comments at 7 (recommending that "payload and non-safety or non-route related information should not be sent over systems using this band.").

⁹⁴ See NTIA *Refresh PN* Comments at 3 (proposing that the scope of services "does not include any messages sent to achieve mission (payload) objectives"); AIA *Refresh PN* Comments at 11.

⁹⁵ See RTCA DO-362A, § 1.1.

⁹⁶ See NTIA *Refresh PN* Comments at 3; see also L3H *Refresh PN* Comments at 2 (arguing that the Commission should prohibit "non-safety-of-life communications in the 5030-5091 MHz band, with the exception of Health & status reports generated by the UAV and sent to the PIC for the sole purpose of ensuring flight reliability and integrity.").

⁹⁷ RTCA DO-362A, Appx. A.

48. Conceivably, the same data from a UA may be both for the purpose of achieving flight mission objectives and for flight safety-related purposes, for example, video transmissions relied upon both as surveillance data and to assist in flight guidance, or UA telemetry data with respect to local weather conditions such as turbulence and wind shear. We seek comment on whether such dual-purpose communications should be permissible if one of the purposes falls within the permissible scope.⁹⁸ Would it better serve the public interest to only include communications that are exclusively for purposes of flight safety or regularity?

49. We seek comment on whether, instead of a general definition of scope or, potentially, as a clarifying and non-exclusive supplement to a general definition, we should specify certain categories of communications that are covered, such as (1) telecommands to the UA; (2) telemetry from the UA that is relied upon for flight guidance or other flight safety-related purposes, such as geo-fencing to protect sensitive areas, i.e., Microwave Landing System sites, radio astronomy sites, adjacent licensees, etc.; (3) DAA-related transmissions; (4) video transmissions from the UA relied upon for flight guidance or other flight safety-related purposes; (5) Air Traffic Control communications relayed via the UA; and (6) remote identification transmissions. We seek comment on whether any of these categories should be narrowed, broadened, eliminated, replaced, or supplemented with other categories.⁹⁹ We seek comment on whether permissible communications should be restricted to communications between the control station and the UA station, i.e., excluding broadcast from the UA or UA-to-UA communications. We further seek comment on whether we should establish priorities among different categories of CNPC, or leave the rules flexible on this matter, with such prioritization potentially to be considered and developed through appropriate standards development by multi-stakeholder groups.¹⁰⁰ Commenters should also consider the impact of these potentially covered communications on the capacity of the band, i.e., whether the addition of these categories of communications allows for sufficient spectrum to support the core purpose of the band, CNPC links.

50. We note that the regulatory definition of AM(R)S limits the allocation to communications “relating to safety and regularity of flight, *primarily along national or international civil air routes.*”¹⁰¹ As the allocation does not require that communications be exclusively for flights along such air routes, we propose not to restrict the scope of permissible CNPC services to such communications. We seek comment on this proposal and the extent to which operations outside civil air routes will need access to

⁹⁸ See Wisk Refresh PN Comments at 6 (stating that Wisk “does not support the use of the band for payload data *except* as required for the safe operation of the payload, and in the case of UAM, safety related communications with the passengers.”) (emphasis added).

⁹⁹ AURA, for example, asserts that categories that can be supported consistent with the AM(R)S allocation include (1) UAS flight control and configuration messages; (2) high priority detect-and-avoid messages; (3) ATC communications; (4) flight safety telemetry messages; (5) other flight safety messages; (7) routine telemetry messages; and (7) air traffic services other than ATC communications. See AURA Refresh PN Comments at 6; cf. RTCA, Minimum Aviation System Performance Standards for C2 Link Systems Supporting Operations of Unmanned Aircraft Systems in U.S. Airspace, RTCA DO-377A (2021) (RTCA DO-377A), Appx. E at E.3, Fig. E-2 (describing the categories of non-payload internal and external information exchange between a control station and a UA as (1) Aircraft Control telecommands; (2) Aircraft Control telemetry; (3) Nav aids Setting Changes; (4) Nav aids Display Data; (5) ATC Voice Relay; (6) Target Data (DAA); (7) Weather Radar Data; (8) Non-Payload Video; and (9) C2 Link Management).

¹⁰⁰ AIA, for example, describes a prioritization of CNPC under the International Civil Aviation Organization (ICAO) Annex 10 Volume VI Part I Standards and Recommended Practices (SARPs) to be applied in both the Forward and Return directions of a “C2 Link System.” See AIA Refresh PN Comments at 11-12. This scheme prioritizes data as follows: (1) UAS flight control and configuration messages; (2) high priority DAA messages; (3) ATC communications including distress calls and urgency messages; (4) flight safety telemetry messages including low priority DAA messages; (5) other flight safety messages; (6) routine telemetry messages; (7) air traffic services other than ATC communications; and (8) other communications related to safety and regularity of flight. See *id.*

¹⁰¹ 47 CFR § 2.1(c) (emphasis added).

the 5030-5091 MHz band for CNPC (as opposed to being able to rely on other spectrum solutions that may or may not provide the same level of reliability or air safety assurance). Assuming some measure is necessary or appropriate to reflect the focus on flights primarily along national or international civil air routes, we seek comment on whether it would be sufficient to ensure that the applicable rules and technical standards provide the necessary reliability and safety to support the use of the band for such flights.

51. We also seek comment on whether we should restrict NNA to CNPC but permit NSS licensees a broader scope such as a scope permitting UAS payload communications or permitting both UAS and non-UAS communications, provided that licensees ensure the safety and reliability of CNPC and ensure that communications associated with the safety of flight always have both priority and preemption over other communications.¹⁰² We see at least two potential distinctions between NNA and NSS operations that may argue for a broader NSS scope of service. First, NSS operations will require deployment of networks that will necessitate a very substantial investment, in contrast to NNA operations that can occur without any network deployment. We seek comment on whether permitting a broader scope of services is necessary to provide adequate financial incentives to support network buildout in NSS spectrum. Second, network technologies may be better positioned than direct-link systems to implement a successful prioritization of CNPC. We seek comment on this possibility, and to what extent current or developing network technologies or architectures are capable of ensuring the safety and priority of CNPC information over that associated with other traffic and whether these technologies or architectures will be compatible with other authorized operations in the band and/or with the TDD requirements of RTCA DO-362A. We seek comment on whether such an expansion of scope would be permissible under section 303(y) of the Communications Act, which places certain limits on the Commission's authority to "allocate electromagnetic spectrum so as to provide flexibility of use."¹⁰³

52. If we conclude that NSS licensees should be permitted a broader scope of permissible communications on an ancillary basis, we seek comment on adding an appropriate allocation if necessary, on what type of allocation should be adopted to support the broader scope, on whether to subject the allocation to secondary status under the AM(R)S allocation and to the limitations applicable to the AM(R)S allocation, and on any measures we should adopt to ensure that the primary use of the spectrum is for CNPC. Should we rely on appropriate multi-stakeholder groups to develop the details of requirements to implement prioritization and preemption? Should any mechanisms for implementing preemption and prioritization be subject to specific review and approval by the Commission, the FAA, and/or an appropriate third-party group?

¹⁰² The standard document RTCA DO-377A appears to endorse further consideration, to the extent permitted under the relevant spectrum allocation, of permitting networks (as opposed to direct links) to provide both CNPC and payload if the relevant spectrum allocations support both, stating that "if a UAS designer selects . . . (a) a C2 Link System architecture that relies on external entities to provide the communication link, e.g., networked terrestrial radios or SATCOM and (b) there is sufficient bandwidth in the link, it may be beneficial to use a single link to transmit both C2 and payload information; provided that the link is able to ensure the safety and priority of C2 information over that associated with the payload(s)." See RTCA, Minimum Aviation System Performance Standards for C2 Link Systems Supporting Operations of Unmanned Aircraft Systems in U.S. Airspace, RTCA DO-377A (2021) (RTCA DO-377A), Appx. A, at A.6.3; see also RTCA DO-377A, Appx. J ("Command and Control and Payload on Same Link"), at J.1 (providing "information related to using a common, or shared, link to support both Command and Control (C2) and payload information exchanges.") (emphasis in original).

¹⁰³ See 47 U.S.C. § 303(y). Specifically, the provision provides that the Commission has a authority to "allocate electromagnetic spectrum so as to provide flexibility of use" if (1) such use is consistent with international agreements to which the United States is a party; (2) such use would not deter investment in communications services and systems, or technology development; and (3) such use would not result in harmful interference among users. *Id.*

5. Eligibility Restrictions

53. We propose that any entity be eligible to obtain a 5030-5091 MHz NSS license other than those precluded by section 310 of the Communications Act and those that are barred under 47 U.S.C. § 1404 from participating in auctions.¹⁰⁴ We seek comment on this proposal and whether eligibility should be more restricted. We further seek comment on how, in this context, we interpret section 310(b), which imposes restrictions on who can hold or be granted a “broadcast or common carrier or aeronautical en route or aeronautical fixed radio station license.”¹⁰⁵ Under the various authorization proposals discussed herein, would a licensee be considered as holding a “common carrier[,] aeronautical en route or aeronautical fixed radio station license”?¹⁰⁶ If so, how should we evaluate any foreign-ownership holdings?

54. We also seek comment on whether to provide that any entity is eligible to operate NNA stations using assignments from a DFMS other than those precluded by section 310 from holding station licenses. Given our proposal elsewhere to license NNA stations by rule, we seek comment on whether section 310 ownership restrictions, which apply to “station licenses,” apply to operators of stations licensed by rule. We further seek comment, if section 310 does not apply to operators of licensed-by-rule stations, on whether NNA station operators, or the parties receiving assignments from a DFMS for such operation, should be subject to eligibility restrictions comparable to those imposed by section 310 on station licensees.

55. NTIA recommends that, to be eligible for a license for 5030-5091 MHz UAS operations, an applicant be required to certify that it has the requisite FAA remote pilot certification or, in the case of an organization, to certify that it will only utilize individuals with this qualification for its UAS operations in the band.¹⁰⁷ Compliance by 5030-5091 MHz operators with applicable FAA remote pilot regulations will be critical to the safe operation of UAS in the 5030-5091 MHz band, and we seek comment on the best approach to achieve this goal, and on NTIA’s proposal as one option. To the extent that we adopt a licensed-by-rule model for NNA as proposed, however, UAS operators will not be required to submit individual license applications, and accordingly, there will be no individual license applications in which UAS operators could make the proposed certifications.¹⁰⁸ Further, provision of network-based NSS would likely involve a network provider’s provision of CNPC services to other entities, and thus, it is likely the relevant UAS operator will be neither a licensee nor an employee of a licensee. Accordingly, we seek comment on whether requiring license applicants to certify that they have the requisite FAA remote pilot certification or will utilize operators with such qualifications is a practical option in either the NNA or NSS context.

56. We further seek comment on the costs and benefits of conditioning either NNA or NSS eligibility on a certification that the party has the necessary FAA remote pilot certification or compliance

¹⁰⁴ See 47 U.S.C. § 310; *id.* § 1404; *see also* 47 CFR § 96.5 (applying similar restrictions to Priority Access Licensees in the 3.5 GHz band).

¹⁰⁵ See 47 U.S.C. § 310(b). Section 310(b) provides that these types of licenses may not be granted to or held by a liens, representatives of a liens, foreign corporations or corporations with specified levels of foreign ownership. *Id.*

¹⁰⁶ 47 U.S.C. § 310(b).

¹⁰⁷ See NTIA *Refresh PN* Comments at 3; *see also, e.g.,* EEI *Refresh PN* Comments at 5-6 (arguing that, to address public safety and security issues, the licensing framework should ensure that individual operators of CNPC links are properly qualified); Wisk *Refresh PN* Comments at 3 (arguing that license eligibility should be conditioned on operator’s ability to meet FAA safety and performance requirements).

¹⁰⁸ See AIA *Refresh PN* Comments at 6 (arguing against license eligibility requirements if stations will be licensed by rule); *see also* Boeing *Refresh PN* Comments at 5 (arguing that a license applicant certification that they have the requisite FAA remote pilot certification would be a helpful precaution only “to the extent the Commission proposes a licensing model that includes individual licensing of UAS operators”).

with other FAA requirements. We seek comment on whether it provides a significant regulatory benefit to specifically limit eligibility in this manner, given that UAS operators using 5030-5091 MHz spectrum will in any case be subject directly to FAA rules and enforcement and would not be able to lawfully operate unless they comply with all applicable FAA requirements. We also seek comment on any administrative concerns from having the Commission potentially be required to interpret and enforce the regulatory regime of another agency. Although Boeing supports such incorporation, it notes that “the FAA is still working to develop a remote pilot certification program for operators of large UAS.”¹⁰⁹ CTIA similarly notes that “FAA rules and regulations are evolving and it is unclear at this juncture what kind of certification, if any, the FAA will require for different types of UAS users.”¹¹⁰ Does the varied and evolving nature of these requirements further argue against importing them into the Commission’s licensing regime?

57. To the extent that there should be some mechanism in addition to the FAA’s enforcement authority to adequately ensure that use of the 5030-5091 MHz band will be consistent with FAA requirements, we seek comment on whether we can instead rely on the DFMS and NSS licensees to ensure that UAS operators have the necessary FAA approvals. For example, to address NNA users, users registering with a DFMS could be required to make the requisite certification as a condition of registration. Alternatively, we might impose a more general requirement on a DFMS to adopt measures that reasonably ensure that operators have the requisite FAA remote pilot authority, and defer to the DFMS administrator (or a multi-stakeholder group) on specific mechanisms to implement this requirement. We seek comment on these and other alternatives.

6. Non-Networked Access (NNA) Service Rules

58. *Licensing rules.* We seek comment on the licensing regime or mechanism we should adopt to enable authorization of NNA operations in the 5030-5091 MHz band and the costs and benefits of any proposed approach. Because we anticipate a large number of operators seeking temporary use of the band, with an even greater number of ground and aircraft stations, we propose to reduce the administrative burdens on such operators and the Commission by adopting a licensing approach that would not require individual licensing of these numerous operators and/or stations. Specifically, we propose to implement a licensed-by-rule authorization for aircraft and ground stations in the band, as recommended by AIA and others.¹¹¹ Under this framework, operators would not be required to apply for individual spectrum licenses for themselves or their mobile or ground stations in order to conduct NNA operations in the band. Instead, parties using rule-compliant stations and operating in compliance with the rules would only need to obtain the requisite temporary frequency assignment from the DFMS in order to transmit in the band in the requested location, frequency, and timeframe. We further propose to permit the stations used by the operator on the ground to send and receive signals to the UA to be either fixed stations or mobile stations (such as hand-held controllers).¹¹² We seek comment, however, on whether to require all NNA ground stations in the band to be fixed stations, and on the costs and benefits of permitting the use of mobile ground stations. To what extent would prohibiting such stations facilitate coordination in the NNA portion of the band, or reduce the likelihood of harmful interference, failures to

¹⁰⁹ Boeing *Refresh PN* Comments at 5.

¹¹⁰ CTIA *Refresh PN* Comments at 8.

¹¹¹ See AIA *Refresh PN* Comments at 5-6 (proposing a framework under which the “pilot/operator would not be the spectrum license holder” and stations would be licensed by rule to use channels assigned on a flight-by-flight basis); *id.* at 13; Qualcomm *Refresh PN* Comments at 8; Wisk *Refresh PN* Comments at 3.

¹¹² As used in this NPRM, the term “mobile station” refers to a station “intended to be used while in motion or during halts at unspecified points.” 47 CFR § 87.5 (mobile service); accord 47 CFR § 2.1 (defining “mobile station” as “[a] station in the mobile service intended to be used while in motion or during halts at unspecified points”); see 47 U.S.C. § 153(34) (“The term ‘mobile station’ means a radio-communication station capable of being moved and which ordinarily does move.”).

comply with assignments, or challenges with administering or policing the system? If we do not permit mobile ground stations, should we differentiate “portable” stations, i.e., stations that can be moved but are not intended to be used while in motion?

59. Section 307(e) of the Act authorizes the Commission to adopt a licensed-by-rule approach for certain specific categories of services, including the “citizens band radio service,” and also expressly delegates to the Commission the discretion to define the scope of the term “citizens band radio service.”¹¹³ In the Commission’s rules, the citizens band radio service is defined as “any radio service or other specific classification of radio stations used primarily for wireless telecommunications for which the FCC has determined that it serves the public interest, convenience and necessity to authorize by rule the operation of radio stations in that service or class, without individual licenses, pursuant to 47 U.S.C. 307(e)(1).”¹¹⁴ Pursuant to this authority, the Commission has provided for licensing by rule of an array of services through inclusion in the citizens band radio service, including the Family Radio Service, the Low Power Radio Service, the Medical Device Radiocommunication Service, the Wireless Medical Telemetry Service, the Dedicated Short-Range Communications Service On-Board Units, and the Part 96 General Authorized Access tier of the 3.5 GHz band.¹¹⁵ We tentatively find that licensing by rule of NNA stations would serve the public interest, convenience, and necessity, and accordingly, we propose to implement licensing by rule by including NNA within the scope of the citizens band radio service.¹¹⁶ We seek comment on our tentative conclusion and proposal, on the scope of our authority under Section 307(e) to adopt a licensed-by-rule approach to UAS operations, and on alternative licensing approaches we might adopt that would not require individual licensing of operators or stations in the band.

60. Section 307(e)(1) also expressly authorizes licensing by rule in “the aviation radio service *for aircraft stations*” but does not provide an equivalent grant of authority to adopt licensing by rule for aviation service ground stations.¹¹⁷ We seek comment on whether we nevertheless have authority in this case to adopt licensing by rule for both aircraft and ground stations in the aviation service. Section 307(e)(3) provides the Commission authority to define “aircraft station” for purposes of section 307(e). We seek comment on whether this provision provides us the authority to define “aircraft station” to include UAS ground stations and whether such an action would serve the public interest.

61. *Technical requirements.* We seek comment on appropriate technical requirements to govern 5030-5091 MHz NNA equipment and operations. In the current record, NTIA, AIA, and many other parties support adoption of the technical requirements in the RTCA DO-362A standard for this purpose.¹¹⁸ RTCA DO-362A contains Minimum Operational Performance Standards (MOPS) for terrestrial-based (i.e., non-satellite) CNPC point-to-point or point-to-multipoint links in the 5030-5091 MHz band, including power limits, emission limits, and frequency accuracy requirements.¹¹⁹ The FAA

¹¹³ 47 U.S.C. § 307(e)(1), (e)(3). The authority provides an exception to the statutory requirement under section 308 of the Act that, aside from cases of emergencies, the Commission may grant station licenses “only upon written application . . .” *Id.* § 308(a).

¹¹⁴ 47 CFR § 95.303.

¹¹⁵ See *3.5 GHz R&O*, 30 FCC Rcd at 4011, paras. 159-61.

¹¹⁶ We note that, while most services that fall under the citizens band radio service category are included in part 95 of the Commission’s rules, the rules for 3.5 GHz General Authorized Access (GAA) stations, which are licensed by rule, are located in part 96. See 47 CFR § 96.1(b).

¹¹⁷ 47 U.S.C. § 307(e)(1).

¹¹⁸ See *NTIA Refresh PN Comments* at 2; see also *AIA Refresh PN Comments* at 10-11; *ASRI Refresh PN Comments* at 5-6; *Boeing Refresh PN Comments* at 2, 6; *NUAIR Refresh PN Comments* at 1; *Wisk Refresh PN Comments* at 2.

¹¹⁹ See RTCA DO-362A §§ 1.1, 1.1.2, 1.4; see also *id.* at Executive Summary. Formally, RTCA DO-362A provides the standards for “CNPC Link Systems,” which are defined as “[t]he combination of airborne and ground UAS

recently issued a Technical Standard Order (TSO) establishing minimum performance standards in the 5030-5091 MHz band based on requirements in RTCA DO-362A.¹²⁰ Accordingly, and in consideration of the current record, we propose to adopt the RTCA DO-362A standard or technical requirements based on that standard to govern NNA equipment and operations and seek comment on this proposal.¹²¹ We seek comment on the adequacy of the RTCA DO-362A specified equipment and operational performance requirements, including both transmitter power and receiver input power, and required minimum coupling loss (separation distance) between ground and airborne CNPC radios and emissions from other licensed radio services.¹²²

62. We seek comment on an appropriate measure of CNPC link reliability to assess RTCA DO-362A and other standards, on the specific anticipated level of CNPC link reliability through radios compliant with the RTCA DO-362A standard, and on any available data that confirms that reliability. We note that some parties have already constructed 5030-5091 MHz UAS radios compliant with RTCA DO-362 and some have also obtained experimental license authorization from the Commission for their operation in the 5030-5091 MHz band.¹²³ We seek comment on any current or past operation of equipment compliant with RTCA DO-362 or RTCA DO-362A, on the results of any such operations, and on the extent to which they support or raise issues or concerns about incorporation of the standard as the governing technical framework for the 5030-5091 MHz band. We also seek comment on whether parties have deployed experimental UAS equipment in the 5030-5091 MHz band in reliance on any other technical standard. Is there any benefit to requiring formal experimental trials or testing for 5030-5091 MHz band equipment?

63. We also seek comment on any costs or disadvantages in imposing the RTCA DO-362A standard. For example, we seek comment on whether and to what extent imposition of this standard may limit the scope of UAS operations that can make use of links in the band. We also seek comment on whether any such limitations are a result of hard constraints codified in the standard on the scope of UAS operations that may occur consistent with the standard specifications, or instead are a consequence of practical constraints, such as if the standard requires the development and installation of radio equipment that may be too heavy for some UA to carry. For example, the standard provides the standards for CNPC

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radios, antennas, and cabling between them that support the data and information exchanges between the UA and the [control station] for the purposes of managing and controlling the flight and operation of a UA.” *Id.* §§ 1.4, 1.9.

¹²⁰ See TSO-C213a; see also *supra* n.19; Boeing *Refresh PN* Comments at 6 (stating that “radios that comply with FAA Technical Standard Order . . . requirements, likely based on RTCA DO-362, will be necessary to ensure aviation safety under the AM(R)S service.”).

¹²¹ See RTCA DO-362A. We note that RTCA SC-228 has been working on a revision of the standard, to be designated DO-362B. See RTCA Special Committee 228, Terms of Reference, Minimum Performance Standards for Unmanned Aircraft Systems, 5 (June 23, 2022), <https://www.rtca.org/wp-content/uploads/2022/06/SC-228-TOR-Rev-1.5-Approved-2022-06-23.pdf> (SC-228 June 2022 Terms of Reference). Below, we seek comment on streamlining the process by which the Commission’s rules can be updated to reflect such a revision. See *infra* para. 74.

¹²² We note that the Commission has recently issued a Notice of Inquiry regarding potential measures that may promote improvements in receiver performance. See *Promoting Efficient Use of Spectrum through Improved Receiver Interference Immunity Performance*, ET Docket No. 22-137, Notice of Inquiry, FCC 22-29 (Apr. 21, 2022). Comments regarding UAS-related receiver performance may also be submitted in that docket.

¹²³ See, e.g., L3H *Refresh PN* Comments at 7 (stating that certain requirements of the standard were “successfully demonstrated in prototype CNPC C Band radios”); uAvionix *Refresh PN* Comments at 1 (stating that uAvionix has obtained experimental licenses for 5030-5091 MHz band radio development in two locations, Bigfork, Montana, and Grand Forks, North Dakota, and that (as of October 12, 2021) flight tests had already begun at Bigfork using radios designed to comply with RTCA DO-362A).

Link Systems, which are limited to communications between a UA and a control station.¹²⁴ We seek comment on whether application of the standard to the band would preclude use of the band for UA-to-UA or broadcast transmissions for purposes such as DAA or Remote ID. Or would transmissions such as Remote ID broadcasts be compatible with communications between ground stations and aircraft so long as the broadcast transmissions complied with the requirements of section 2.2.1 of RTCA DO-362A that are applicable to aircraft stations?¹²⁵ Some have also asserted that application of the standard may restrict permissible operations to flights transitioning in and out of Class A airspace.¹²⁶ We seek comment on the extent to which requiring compliance with RTCA DO-362A would strictly or effectively limit operations in this manner.

64. Canada states that some technical incompatibilities have been identified between RTCA DO-362A and a proposed standard by the European Organization for Civil Aviation Equipment (EUROCAE) for satellite-based CNPC in the same band, designated draft ED-265, and asserts that adoption of the RTCA DO-362A standard without addressing the incompatibilities may create difficulties in managing the operation of CNPC links in support of international UAS operations.¹²⁷ We seek comment on these concerns, the nature of the incompatibilities, and what, if any, measures, requirements, or restrictions are necessary to address them.¹²⁸ We note that RTCA has been considering the “ED-265/DO-362 interference issue.”¹²⁹ We seek comment on any determinations that have been made regarding these incompatibilities and whether the issue is adequately addressed in the current RTCA DO-362A version of the standard or will be addressed in a future version. If revisions to RTCA DO-362A are necessary or appropriate to address these issues, we seek comment on whether the next version of the standard is anticipated to be backwardly compatible with RTCA DO-362A, and if not, whether adoption of final rules should be deferred until these issues are resolved in a new version of the standard. We seek comment on whether any coordination or other requirements are necessary to ensure adequate protection of foreign satellite-based CNPC services in the band, particularly insofar as they may operate near United States jurisdictional boundaries. We also note that footnote 5.443C of the Table of Frequency Allocations limits the use of the 5030-5091 MHz band to “internationally standardized aeronautical systems.”¹³⁰ We seek comment on whether this provision requires the Commission to adopt a standard that is compatible

¹²⁴ See RTCA DO-362A, § 1.2 (“[T]his CNPC Link System MOPS document addresses only the CNPC Link System, which is part of a larger system that seeks to exchange information between a UA and its Control Station”).

¹²⁵ See RTCA DO-362A, § 2.2.1.

¹²⁶ See CTIA *ALA* Petition Comments at 9. Class A airspace is the airspace from 18,000 feet mean sea level (MSL) up to and including flight level (FL) 600. See FAA, *Airspace Classification*, https://aspm.faa.gov/aspmhelp/index/Airspace_Classification.html (last visited Sept. 6, 2022).

¹²⁷ See Canada *Refresh PN* Comments at 1; see also EUROCAE *Open Consultation, ED-265*, <https://www.eurocae.net/news/posts/2019/may/eurocae-open-consultation-ed-265/> (last visited Sept. 6, 2022).

¹²⁸ While Canada does not describe the nature of the incompatibility to which it refers, and no other commenter discusses incompatibilities between the RTCA DO-362A standard and the EUROCAE standard, discussions before ICAO have focused on the difference in TDD time frames between the two standards; RTCA DO-362A terrestrial links relies on a 50 ms time frame to minimize latency, while the satellite-based links under ED-265 would use a 300 ms time frame. See, e.g., ICAO, *C2 Link 5 GHz Band Planning – Status Update – RPAS Panel WG2*, at 3-4 (Oct. 2021), https://www.icao.int/safety/FSMP/MeetingDocs/FSMP%20WG12/IP/FSMP-WG12-IP01_C%20Band%20Planning_20210924.pptx (last visited Sept. 6, 2022); see also *id.* at 5 (“[G]iven the different TDD time frames, the potential for Air-to-Air and Ground-to-Ground interference between the terrestrial and satellite equipped UA and ground systems exists.”).

¹²⁹ RTCA-228, Summary of Plenary #30 RTCA Paper No. 183-21/SC228-089, 2 (July 16, 2021), <https://www.rtca.org/wp-content/uploads/2021/08/228sum30.pdf> (summary of the thirtieth plenary meeting of RTCA SC-228); see also SC-228 June 2022 Terms of Reference at 2 (stating that in the Phase Three update of RTCA DO-362A, the standard will be “harmonized with C-band satcom usage internationally, if required”).

¹³⁰ 47 CFR § 2.106, footnote 5.443C.

with the EUROCAE standard, and whether RTCA DO-362A would meet our obligations under footnote 5.443C.

65. If we incorporate the RTCA DO-362A standard into our rules, we seek comment on whether to do so through adoption of a general requirement that, to be certified for use under or operated under the NNA rules, all radio equipment must comply with the requirements of RTCA DO-362A, rather than to separately incorporate the various technical requirements of RTCA DO-362A (e.g., power, frequency stability, and emission limitations) into the service rules.¹³¹ If we adopt a general requirement to comply with RTCA DO-362A, we propose to also separately codify requirements for power and emission bandwidth based on the RTCA DO-362A standard, to provide clarity and ease of reference in the rules.¹³² If, alternatively, we do not have a requirement of general compliance with RTCA DO-362A, but require compliance with only selected provisions of the standard, which provisions or requirements from RTCA DO-362A should we impose? Which specific provisions of RTCA DO-362A are necessary for compatible use of the 5030-5091 MHz band? Should the Commission's technical framework require compliance more broadly with section 2, the Equipment Performance Requirements and Test Procedures applicable to the link system radios, or both sections 2 and 3, the latter of which includes performance standards for the link system when installed in a UA and ground location?¹³³ Alternatively, is it sufficient, for purposes of establishing the baseline technical framework, to require compliance with the specific frequency capture range (which includes a frequency accuracy standard), power limits, and emission limits stipulated by the standard?¹³⁴

66. RTCA states that emission limit requirements should also require equipment compliance with the 50 ms Time Division Duplex (TDD) requirements specified under section 2.2.1.3 of the standard.¹³⁵ It asserts that use of non-TDD systems or TDD systems with different time length frames operating in the 5030-5091 MHz band within the same radio horizon as RTCA DO-362A compliant equipment will cause unacceptable levels of interference.¹³⁶ We seek comment on RTCA's assertion and recommendation, and whether adoption of the standard for NNA will necessarily require all equipment in the band, including equipment in neighboring NSS blocks, to use RTCA DO-362A compliant TDD equipment to avoid harmful interference to NNA operations.

67. We seek comment on whether any of the general technical requirements in subpart D of part 87 should apply to NNA equipment. NTIA proposes, for example, that in addition to meeting the out-of-band emissions limits in RTCA DO-362A, we should also require equipment to meet the out-of-band emissions limit specified in section 87.139(c).¹³⁷ RTCA argues, however, that the current

¹³¹ See Appendix A (Proposed Rules).

¹³² See Appx. A, §§ 88.101, 88.103; see also RTCA DO-362A, §§ 2.2.1.6.1.1.1 (C Band ARS Radio Transmitter Output Power (High-Power Mode)), 2.2.1.6.1.1.2 (C Band ARS Radio Transmitter Output Power (Low-Power Mode)), 2.2.1.5.2 (Channel Width), 2.2.1.5.5 (Video Channels), § 2.2.1.5.6 (Non-Video Channels).

¹³³ See RTCA DO-362A, §§ 2, 3. Section 3 requirements are imposed out of recognition that “[s]ome CNPC Link System attributes and performance may be affected by factors resulting from integration into the UAS.” RTCA DO-362A, § 3.

¹³⁴ See NTIA *Refresh PN* Comments at 2; RTCA *Refresh PN* Comments at 6; see also RTCA DO-362A §§ 2.2.1.4 (frequency capture range), 2.2.1.6.1 (power limits), 2.2.1.6.2 (emission/output power spectral density limits). RTCA flags the section 2.2.1.6 power and emission limits (stating that these requirements have been made “more stringent” than in the original RTCA DO-362 standard) but recommends we require compliance with transmitter EIRP and EIRP spectral density emissions requirements under section 3.2.1.42. See RTCA *Refresh PN* Comments at 6.

¹³⁵ See RTCA *Refresh PN* Comments at 6. See also AIA *Refresh PN* Comments at 11 (supporting a requirement that transmitters comply with the 50 ms TDD requirements of RTCA DO-362A § 2.2.1.3).

¹³⁶ See RTCA *Refresh PN* Comments at 6.

¹³⁷ See NTIA *Refresh PN* Comments at 2. Section 87.139(c) of the Commission's rules provides that “[f]or a aircraft station transmitters first installed after February 1, 1983, and for a aeronautical station transmitters in use after

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requirements of section 87.139(c) are less stringent than those in RTCA DO-362A, and that the Commission should just require compliance with the latter.¹³⁸ L3H asserts that it is not clear whether section 87.139 is applicable, as it applies only to communications using certain specific Emissions Designators and the RTCA DO-362A mandatory modulation makes no reference to these designators.¹³⁹ We seek comment on NTIA's proposal, on whether section 87.139(c) may, under its existing terms, apply to UAS communications anticipated in the 5030-5091 MHz band, and whether such application is in the public interest. We further seek comment on whether we need to specify authorized emission classes and designators for this service, such as has been done with aviation services.¹⁴⁰ If so, we seek comment on what classes and designators are appropriate, and whether we should use one of the types of assignable emissions already defined in, for example, section 87.137 of the rules.¹⁴¹ We propose emission designators of G8D for data and G8F for video and seek comment on their appropriateness for operations subject to RTCA DO-362A.¹⁴²

68. We seek comment on any other requirements we should impose on NNA equipment. For example, what requirements should we adopt to facilitate a DFMS's ability to communicate with or otherwise control such equipment in the execution of the DFMS's responsibilities? Should equipment be required to enable the DFMS to make direct (machine-to-machine) frequency assignments to the UAS equipment, in order to ensure that assignments are accurately programmed? Should this capability be available at all times, or only pre-flight? To the extent DFMS communications or control signals are intended to affect operating parameters of the UA, should such communications or control signals be required to occur exclusively through communications between the DFMS and the relevant ground control station or stations, rather than through direct communications with a UA station? In the 3.5 GHz band, fixed stations must respond automatically to SAS directions to modify certain operational parameters such as frequency or power limit.¹⁴³ Should requirements be adopted for NNA equipment to provide the DFMS with similar control? We further seek comment on whether to impose requirements to ensure interoperability between NNA and NSS network services. Potentially, UA flights that initially rely on a network service may extend into areas where no network has been deployed. What requirements, if any, should we adopt to facilitate operations that can seamlessly switch between network service for CNPC and NNA assignments for that purpose?

69. We note that RTCA has also adopted another standard applicable to CNPC in the 5030-5091 MHz band, designated RTCA DO-377A, Minimum Aviation System Performance Standards for C2

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February 1, 1983, and using H2B, H3E, J3E, J7B or J9W, the peak envelope power of any emissions must be attenuated below the peak envelope power of the transmitter (pX) as follows: (1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 30 dB. (2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 38 dB. (3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 3.0 kHz for aircraft transmitters the attenuation must be at least 43 dB. For aeronautical station transmitters with transmitter power up to and including 50 watts the attenuation must be at least $43 + 10\log_{10} pX$ dB and with transmitter power more than 50 watts the attenuation must be at least 60 dB." 47 CFR § 87.139(c).

¹³⁸ See RTCA Refresh PN Comments at 6.

¹³⁹ See L3H Refresh PN Comments at 9.

¹⁴⁰ See 47 CFR § 87.131.

¹⁴¹ See 47 CFR § 87.137 (providing the assignable emissions for part 87 services and corresponding emission designators and authorized bandwidths).

¹⁴² See 47 CFR § 2.201; see also Appx. A, § 88.105.

¹⁴³ See 47 CFR § 96.39(c)(2).

Link Systems Supporting Operations of Unmanned Aircraft Systems in U.S. Airspace (RTCA DO-377A).¹⁴⁴ Whereas RTCA DO-362A describes minimum performance standards for the ground and airborne radios used for a direct link, focusing on certain design characteristics of these radios such as power and emissions limits, RTCA DO-377A describes the minimum performance of an overall “C2 Link System,” defined as a system used to send information exchanges between a control station and an unmanned aircraft and to manage the connection between them, and which can be comprised of one or many Air/Ground links and Ground/Ground links.¹⁴⁵ RTCA DO-377A can be applied to systems relying on a direct connection or systems relying on network functionality for the connection, and focuses on system requirements, including system performance, safety, and security requirements.¹⁴⁶ To the extent that RTCA DO-377A applies to NNA operations, we seek comment on whether we should adopt rules requiring compliance with the standard.¹⁴⁷ Alternatively, should we limit our requirements, as AIA recommends, to technical requirements based on RTCA DO-362A and leave system performance, safety, and security requirements, such as those in RTCA DO-377A, to be considered by a multi-stakeholder group or addressed by the FAA?¹⁴⁸

70. *Application of Part 87 Aviation Service Rules and Part 1 Wireless Radio Service Rules.* We seek comment on where to locate the new NNA services rules within the organization of the Commission’s rules. Some parties argue that the new service should be located in part 87,¹⁴⁹ which “states the conditions under which radio stations may be licensed and used in the aviation services.”¹⁵⁰ We seek comment on this option. We note, however, that the new services may not entirely fit within the scope of “aviation services,” which are defined as “[r]adio-communication services for the operation of aircraft.”¹⁵¹ For example, we seek comment above on whether to permit non-CNPC traffic, such as payload communications, which would be communications to achieve mission objectives and not for the “operation of aircraft.” In addition, it may be appropriate to locate the new NNA and NSS service rules

¹⁴⁴ See RTCA DO-377A. Like RTCA DO-362A, RTCA DO-377A is a revision of the original version of the standard, RTCA DO-377.

¹⁴⁵ See RTCA DO-377A, §§ 1.2, 3.2.1.

¹⁴⁶ See, e.g., RTCA DO-377A at 1.1.2. Although it appears that RTCA DO-377A’s performance standards can be applied to any C2 Link System, we note that commenters in this proceeding have generally described the requirements of RTCA DO-377A in the context of network-based CNPC. See, e.g., AIA *Refresh PN* Comments at 6 (asserting that network providers of CNPC must “meet[] aviation performance levels and the safety requirements (in DO-377A) that govern a proposed network of [ground stations] and services”); *id.* at 8 (stating that RTCA DO-377A “guides the implementation of ground networks”); uAvionix *Refresh PN* Comments at 1; Wisk *Refresh PN* Comments at 2 n.5 (“DO-377A provides a basis for the safety, performance, and security standards that a CNPC network should meet . . .”).

¹⁴⁷ While we do not anticipate that wide-area networks will be deployed in reliance on NNA assignments because of the highly transient nature of the relevant spectrum rights, we do not propose to prohibit operators from using their temporary assignments with fixed network infrastructure. Potentially, parties might use these transient spectrum rights in connection with limited infrastructure deployment, such as a string of ground stations deployed over a particular and frequently used flight path. We invite commenters to discuss whether and to what extent the minimum performance standards of RTCA DO-377A would apply in such cases.

¹⁴⁸ See AIA *Refresh PN* Comments at 8, 13-14 (advocating that “the basis of initial service rules” should be “found in RTCA DO-362A” and “aviation-specific requirements based on DO-377A should be developed “by members of the UAS standards-making community”); WInnForum *Refresh PN* Comments at 3 (advocating that the Commission establish rules with “the minimum necessary technical restrictions to provide a dequate protection against harmful interference”). Above, we address in further detail the potential reliance on a multi-stakeholder group to further develop recommendations or standards for DFMS and CNPC operation in the 5030-5091 MHz band.

¹⁴⁹ See, e.g., AIA Petition at ii.

¹⁵⁰ 47 CFR § 87.1(b).

¹⁵¹ 47 CFR § 87.5.

together, and we anticipate that NSS licenses will differ from traditional aviation services in a number of other ways. For example, unlike licenses in traditional aviation services, we anticipate that NSS licenses will provide exclusive rights to spectrum.¹⁵² Further, we expect that NSS licenses will be used for the provision of commercial wireless network services and will therefore raise a number of issues more comparable to those involved in the regulation of commercial network services than the regulation of traditional aviation services, such as considerations of promoting service competition and network build-out, as well as possible license auction issues. In addition, the current part 87 rules were not adopted with UAS in mind, and many of the rules in part 87, even in sections otherwise generally applicable to part 87 services, may be unnecessary or inappropriate to apply to UAS communications or to the 5030-5091 MHz services specifically.¹⁵³ Locating the rules in a new rule part may therefore provide greater clarity and ease of reference in determining the rules applicable to the band. Finally, locating the rules for the 5030-5091 MHz band in a new rule part would not be inconsistent with its allocation for AM(R)S. Whether or not the rules are in part 87, the band will remain protected aviation spectrum allocated for AM(R)S and rules under this allocation can be adopted to achieve the safety and reliability appropriate for communications “relating to the safety and regularity of flight,” regardless of where the rules are located.¹⁵⁴ Accordingly, we seek comment on whether we should locate the new UAS rules in a new rule part rather than in part 87, as reflected in Appendix A.¹⁵⁵ We further seek comment on alternative options for the appropriate home for the new rules.

71. Whether we locate the rules for the 5030-5091 MHz band in part 87, a new rule part, or elsewhere, we seek comment on whether and to what extent the generally applicable rules in subparts B through F of part 87 should apply to or be incorporated into the new NNA service, either in their current form or with modifications.¹⁵⁶ We ask commenters that argue for application of these general part 87 rules to be specific as to which provisions they recommend should be applied, and what, if any, modifications they propose. We anticipate that many of these provisions will be unnecessary, superseded, or otherwise inappropriate as a result of the specific requirements we adopt for the new service. For example, section 87.41 (Frequencies) in subpart B provides rules for the request and coordination of specific frequencies. Given the proposal for frequency management by a DFMS, is this provision entirely superseded, or is there an aspect of this provision that should apply to NNA assignments?

72. As another example, section 87.89 requires that, with certain exceptions, operators of licensed aviation service stations “must hold a commercial radio operator license or permit.”¹⁵⁷ The

¹⁵² See 47 CFR § 87.41(b) (providing that frequencies are available for part 87 aviation services “on a shared basis only and will not be assigned for the exclusive use of any licensee”).

¹⁵³ See, e.g., CTIA *AIA Petition* Comments at 15 (arguing that part 87 rules were “designed for *manned* aircraft,” that “there are critical differences among *manned* aircraft and *unmanned* aircraft,” including different risk considerations, that “regulations for each should be appropriate,” and that a new rule part for UAS would be “more workable than attempting to retrofit rules intended for manned aviation to accommodate UAS.”) (emphasis in original). We seek comment below on the extent to which the substance of specific part 87 requirements should be applied to NNA operations.

¹⁵⁴ See 47 CFR § 2.1 (definition of AM(R)S).

¹⁵⁵ See *supra* Appx. A.

¹⁵⁶ See 47 CFR pt. 87, subpts. B (Applications and Licenses), C (Operating Requirements and Procedures), D (Technical Requirements), E (Frequencies), F (Air Craft Stations). Above, we discuss in greater detail possible technical requirements, including possible application of the general part 87 technical provisions in subpart D.

¹⁵⁷ 47 CFR § 87.89(a); see also FCC, *Commercial Radio Operator License Program*, <https://www.fcc.gov/commercial-radio-operator-license-program> (last visited Sept. 6, 2022) (“FCC rules require that licensees of [aviation service] stations permit only persons holding the appropriate FCC-issued commercial operator license to perform specified transmitter operation, maintenance and repair duties.”). We note that this part 87 requirement is subject to the general waiver of the operator license requirement for *subscribers* of a Wireless Radio Service. See 47 CFR § 1.903(c); see also *id.* § 1.907 (providing that part 1 Wireless Radio Services include, *inter*

(continued....)

operator license requirement is distinct from and wholly independent of the requirement that each station be licensed and requires individuals seeking an operator license to demonstrate, by passing a formal examination, sufficient knowledge of the relevant radio technologies.¹⁵⁸ The operator license requirement stems from section 318 of the Act, which requires operators of transmitting equipment of licensed stations to hold an operator's license, except where the Commission finds that the public interest, convenience, or necessity will be served by waiving such requirement.¹⁵⁹ Some parties in the record have suggested that the Commission adopt operator license requirements for all UAS operators that use 5030-5091 MHz radio equipment, or at least impose the equivalent knowledge requirements on such operators.¹⁶⁰ Others have argued against such a requirement. For example, some assert that the Commission should defer to the FAA as the expert agency over aircraft pilot qualifications and rely on the FAA's regulations establishing the testing and certification of UAS operators instead of establishing its own UAS operator licensing or permit requirement.¹⁶¹ Some also suggest that requiring all operations to be performed by licensed UAS operators might unintentionally prohibit autonomous UAS operations that do not require human operators.¹⁶² We seek comment on whether, in addition to the station license (which, as discussed, we propose to provide through licensing by rule), we should require UAS operators using a NNA assignment in the 5030-5091 MHz band to have an individual operator license. Conversely, would it be in the public interest to forgo any such operator licensing or permitting requirements as unnecessary or inappropriate in light of FAA regulation of and authority over UAS remote pilot qualifications, or for other reasons?

73. We also seek comment on whether the new service should be subject to rules under part 1, subpart F governing "Wireless Radio Service" applications and proceedings.¹⁶³ The "Wireless Radio Services" are already defined to include licensed-by-rule services such as those under parts 95 and 96, as well as public and private part 87 aviation services, although not all of these subpart F provisions apply to licensed-by-rule services, such as those requirements governing license applications.¹⁶⁴ Accordingly, we seek comment on whether NNA services, even if licensed by rule, should be included in and subject to the subpart F rules for Wireless Radio Services to the same extent as other licensed-by-rule services.

74. *Streamlined procedures to update incorporated standards.* We anticipate that any technical standard developed by a standards organization that we incorporate by reference into our rules will be subject to ongoing revisions as parties gain more experience and the UAS industry continues to rapidly evolve. For example, RTCA DO-362A, which we consider above, is a 2020 revision of the

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alia, part 87 services). Given that NNA assignments are intended to provide operators with direct access to spectrum, however, it appears unlikely that many UAS operators that rely on NNA assignments will be doing so as subscribers of a Wireless Radio Service.

¹⁵⁸ See FCC, *Examinations*, <https://www.fcc.gov/wireless/bureau-divisions/mobility-division/commercial-radio-operator-license-program/examinations> (last visited Sept. 6, 2022).

¹⁵⁹ 47 U.S.C. § 318.

¹⁶⁰ See, e.g., AIA Petition at 9. AIA proposes that operators be required to pass a test incorporating "Element 3" of the Commission's operator license examination. See AIA Petition at 9. Element 3 covers knowledge of the electronic fundamentals and techniques required to adjust, repair, and maintain radio transmitters and receivers. See FCC, *Examinations*, <https://www.fcc.gov/wireless/bureau-divisions/mobility-division/commercial-radio-operator-license-program/examinations#block-menu-block-4> (last visited Sept. 6, 2022).

¹⁶¹ See CTIA *AIA Petition* Comments at 19-20; Small UAV Coalition *AIA Petition* Comments at 7.

¹⁶² See Small UAV Coalition *AIA Petition* Comments at 6.

¹⁶³ See 47 CFR pt. 1, subpt. F (Wireless Radio Services Applications and Proceedings). The term "Wireless Radio Services" or WRS is defined as "[a]ll radio services authorized in parts 13, 20, 22, 24, 26, 27, 30, 74, 80, 87, 90, 95, 96, 97 and 101 of this chapter, whether commercial or private in nature." 47 CFR § 1.907. Thus, WRS is an umbrella designation covering a wide range of terrestrially-based licensed wireless services.

¹⁶⁴ See 47 CFR § 1.907 (definition of "Wireless Radio Services").

RTCA DO-362 standard issued by RTCA in 2016, and RTCA Special Committee 228 (SC-228) is already working on a second revision.¹⁶⁵ Accordingly, we anticipate that the rules will need to be revisited in the future to reflect important and beneficial standard updates. In the past, the Commission has found it in the public interest to streamline the process for incorporating updates to a previously adopted standard, by delegating rulemaking authority to one or more Bureaus for this purpose.¹⁶⁶ To help ensure that the rules for 5030-5091 MHz UAS operations continue to reflect the most current version of any incorporated standard for 5030-5091 MHz UAS operations, we invite comment on whether we should adopt a comparable delegation of rulemaking authority in this case. Specifically, we seek comment on whether to delegate joint rulemaking authority to WTB and OET to incorporate into the Commission's rules, after consultation with the FAA and NTIA, and notice and an opportunity for public comment, any updated version of a previously incorporated technical standard applicable to UAS operations in the 5030-5091 MHz band.¹⁶⁷ Similar to limitations the Commission has placed in some earlier delegations of rulemaking authority to update standards, should we limit this delegated authority to the incorporation of standard updates that do not raise major compliance issues?¹⁶⁸

7. Network Supported Service (NSS) Service Rules

75. We seek comment on the license terms and service rules we should adopt for NSS licenses. We seek comment in particular on issuing exclusive use, geographic area defined licenses for a specific term of years, with rights of renewal, subject to specific performance (network coverage) obligations. We seek comment on appropriate technical and operational requirements and on the assignment process rules.

76. *Geographic area licenses.* Consistent with our approach in several other bands that has promoted the deployment of wide area networks for a variety of fixed and mobile services,¹⁶⁹ we propose to license NSS spectrum blocks in the 5030-5091 MHz band for exclusive use on a geographic area basis. Geographic area licensing provides certainty to licensees and promotes efficient spectrum use, among other things, and will give licensees siting flexibility that will promote the deployment of wide area networks in the 5030-5091 MHz band. Geographic area licensing will also help to facilitate rapid assignment of licenses, utilizing competitive bidding when mutually exclusive applications are received.¹⁷⁰ We seek comment on this approach, on its costs and benefits, and on alternative licensing approaches. If a party opposes using geographic licensing, it should explain its position, describe the

¹⁶⁵ See, e.g., SC-228 June 2022 Terms of Reference at 5 (indicating that DO-362B has a due date of October 2023).

¹⁶⁶ See, e.g., *Section 68.4(a) of the Commission's Rules Governing Hearing Aid-Compatible Telephones*, WT Docket 01-309, Report and Order, 18 FCC Rcd 16753, 16779, para. 63 (2003); *Amendment of the Commission's Rules Governing Hearing Aid-Compatible Mobile Handsets*, WT Docket No. 07-250, First Report and Order, 23 FCC Rcd 3406, 3441, para. 87 (2008); *Access to Telecommunication Equipment and Services by Persons with Disabilities; Amendment of the Commission's Rules Governing Hearing Aid-Compatible Handsets*, CG Docket No. 13-46, WT Docket Nos. 07-250, 10-254, Report and Order and Order on Reconsideration, 32 FCC Rcd 9063, 9092, Appx. B (2017) (expanding rulemaking delegation codified at section 20.19(k)); see also *Structure and Practices of the Video Relay Service Program, Telecommunications Relay Services and Speech-to-Speech Services for Individuals with Hearing and Speech Disabilities*, GC Docket Nos. 10-51, 03-123, Report and Order and Further Notice of Proposed Rulemaking, 28 FCC Rcd 8618, 8643, para. 49 (2013).

¹⁶⁷ While we invite comment on this issue, we note that it involves potential rules regarding a agency organization, procedure, or practice, which are not subject to notice-and-comment rulemaking requirements under section 553 of the Administrative Procedure Act. See 5 U.S.C. § 553(b)(A).

¹⁶⁸ Cf. 47 CFR §§ 0.241(a)(1)(ii), 20.19(k)(2).

¹⁶⁹ See, e.g., 47 CFR § 27.6(h), (i), and (m) (AWS-1, AWS-4, and 3.7 GHz Service bands, respectively).

¹⁷⁰ See, e.g., *Facilitating Shared Use in the 3100-3550 MHz Band*, WT Docket No. 19-348, Report and Order and Further Notice of Proposed Rulemaking, 35 FCC Rcd 11078, 11098, para. 56 (2020).

licensing scheme it supports, and identify the costs and benefits associated with its alternative licensing proposal.

77. We further seek comment on the appropriate geographic license area or areas for NSS licenses to support NSS UAS operations and facilitate investment, including investment by small entities, and robust spectrum use. We seek comment on whether we should adopt larger license areas such as Regional Economic Area Groupings (REAG) or nationwide markets to facilitate NSS uses that may often involve flight over long distances, adopt a more granular scheme such as Partial Economic Areas (PEA), which would provide more flexibility to serve a smaller area but still permit parties to achieve a larger area through aggregation, or adopt a mix of large and small license areas for different spectrum blocks.¹⁷¹ While NTIA supports licensing by REAG, AIA argues in its *Refresh PN* comments that license areas corresponding to the Air Route Traffic Control Center (ARTCC) areas or other areas “that make sense in an aviation system context” would be appropriate, and Wisk similarly recommends use of the ARTCC areas to provide “alignment with a general air traffic density basis.”¹⁷² We seek comment on whether to adopt license areas based on a geographic area division of the country that has been developed specifically for aviation purposes, such as the ARTCC areas.

78. *License term.* We propose to issue NSS licenses for an initial 15-year term. AIA and Wisk both support a license term “longer than 10 years,”¹⁷³ and we believe that circumstances in the band, including the need to set up a DFMS in the band and integrate its functions with operations in NSS spectrum, as well as the nascent stage of standards development and other technical work regarding NSS networks generally, favor the use of a longer initial license term. We propose to limit subsequent terms to 10 years. We seek comment on these proposals.

79. *Performance (network build-out or coverage) requirements.* The Commission also generally establishes build-out or coverage requirements for licenses, referred to as performance requirements, to ensure that spectrum is intensely and efficiently used and as mandated by the Act for auctioned spectrum.¹⁷⁴ We seek comment on performance requirements that are appropriate for NSS licensees and UAS operation. We seek comment in particular on whether to adopt a population-based performance metric, such as a requirement to cover at least 80 percent of the population in the license area within 12 years of the grant of the license, as the Commission recently adopted for geographic

¹⁷¹ REAGs divide the nation, including its territories, into 12 areas, while PEAs divide it into 416 areas. See *Regional Economic Area Groupings*, <https://www.fcc.gov/file/13212/download> (REAG map) (last visited Sept. 6, 2022); *Wireless Telecommunications Bureau Provides Details About Partial Economic Areas*, GN Docket No. 12-268, Public Notice, 29 FCC Rcd 6491, 6491 (WTB 2014).

¹⁷² Compare NTIA *Refresh PN* Comments at 5 (asserting that REAGs “would likely best support such UAS use”), with AIA *Refresh PN* Comments at 14 (supporting ARTCCs or “other geographical areas that make sense in an aviation system context”); Wisk *Refresh PN* Comments at 2 n.6 (supporting ARTCCs “[f]or simplicity and alignment with a general air traffic density basis”). But see AIA Feb. 1, 2022 *Ex Parte*, Attach. at 7 (suggesting that geographic area licenses could also be issued for some blocks on a state-wide or nationwide basis). Each Air Route Traffic Control Center (ARTCC) provides, within a defined region of the country, air traffic services to aircraft operating on an Instrument Flight Rule (IFR) Flight Plan in controlled airspace, principally during the “en route” phase of the flight. See *Air Route Traffic Control Center*, <https://www.cfinotebook.net/notebook/air-traffic-control/air-route-traffic-control-center> (last visited Sept. 6, 2022). There are 22 ARTCC regions covering the United States. See FAA, *ARTCC*, https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/air_traffic_services/artcc (last visited Sept. 6, 2022); AVweb, *Air Route Traffic Control*, <https://www.avweb.com/flight-safety/faa-regs/air-route-traffic-control/> (last visited Sept. 6, 2022) (displaying a map of the 20 ARTCC areas covering CONUS).

¹⁷³ See AIA *Refresh PN* Comments at 14 (stating that the initial term “should be “longer than 10 years to begin with, while the market is in its infancy, to encourage early investment”); Wisk *Refresh PN* Comments at 6.

¹⁷⁴ See 47 U.S.C. § 309(j)(4)(B).

licenses in other bands.¹⁷⁵ We also seek comment on whether to adopt an appropriate interim performance requirement, such as a requirement to cover at least 45 percent of the population in the license area within six years of license grant.¹⁷⁶

80. While some parties support population-based coverage requirements for NSS licensees,¹⁷⁷ AIA argues that population is not an appropriate benchmark in this context, because “the spectrum will be used by aircraft rather than people on the ground,” including for “crop examination, border surveillance, and travel over sparsely populated areas[.]”¹⁷⁸ AIA argues that such uses require reliable control links for all geographic areas of flight regardless of proximity to population centers, and suggests that a build-out requirement based on “user demand, special diversity and signal strength” would better meet the needs of beyond-radio-line-of-sight UAS operations.¹⁷⁹ We seek comment on AIA’s arguments, and on whether we should either require licensees to meet some criteria other than population, such as geographic area coverage of 25% of the license area at year six and 50% of the license area at year 12.¹⁸⁰ Alternatively, should we provide licensees with the option of meeting either a population-based requirement or some alternative? To the extent commenters recommend alternative build-out requirements, we ask them to propose either specific numerical benchmarks or other specific and objectively verifiable buildout criteria.

81. We seek comment on appropriate rules for compliance demonstration and enforcement. As for compliance demonstration, we propose to adopt a process similar to compliance rules applicable to part 27 licensees, requiring a demonstration of compliance with the performance requirements by filing a construction notification with the Commission within 15 days of the expiration of the applicable benchmark, including electronic coverage maps accurately depicting the boundaries of the licensed area and the boundaries of the actual areas to which the licensee provides service.¹⁸¹ If a coverage map is used to demonstrate compliance, we seek comment on the appropriate standardized parameters for the propagation model. For example, should there be standardized values for inputs such as cell edge probability, cell loading, and clutter? As for enforcement, we propose that if a licensee fails to meet the final performance requirement, the license authorization will terminate automatically without specific Commission action.¹⁸² If we adopt an interim requirement, we propose that failure to meet the requirement would result in the reduction by two years of both the due date for the final performance requirement and the license term (resulting in a final performance requirement at year 10 and a license term of 13 years).¹⁸³

¹⁷⁵ See *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, GN Docket No. 18-122, Report and Order and Order of Proposed Modification, 35 FCC Rcd 2343, 2385, para. 93 (2020) (*3.7 GHz R&O*); *Review of the Commission’s Rules Governing the 896-901/935-940 MHz Band*, WT Docket No. 17-200, Report and Order, Order of Proposed Modification, and Orders, 35 FCC Rcd 5183, 5235, para. 129 (2020) (*900 MHz Service Rules R&O*). We note that some parties within the aviation community use the term “performance requirements” to refer to a particular minimum technical or operational standard of performance. See, e.g., AIA *Refresh PN* Comments at 14. We do not seek comment on such requirements here; rather, we use “performance requirements” as the Commission has customarily used it, to refer to deadlines on licensees for meeting certain deployment or coverage milestones.

¹⁷⁶ See *3.7 GHz R&O*, 35 FCC Rcd at 2385, para. 93; *900 MHz Service Rules R&O*, 35 FCC Rcd at 5235, para. 129.

¹⁷⁷ See L3H *Refresh PN* Comments at 16; see also *id.* at 18 (asserting that “[s]imilar to cellular phone service, commercial UAS rollout of terrestrial services is likely to follow population density”).

¹⁷⁸ See AIA *Refresh PN* Comments at 15.

¹⁷⁹ See *id.*

¹⁸⁰ See, e.g., *900 MHz Service Rules R&O*, 35 FCC Rcd at 5235, para. 130.

¹⁸¹ See 47 CFR §§ 1.946(d), 27.14(k).

¹⁸² See 47 CFR § 1.946(c).

¹⁸³ See, e.g., 47 CFR § 27.14(g)(1), (h)(1), (r)(3).

82. *License Renewal.* We seek comment on the appropriate standard for license renewal. In the *WRS Second R&O*, the Commission adopted a unified regulatory framework for the Wireless Radio Services (WRS) that replaced the existing patchwork of service-specific rules regarding renewal with a single unified standard, and safe harbors for meeting that standard for different service categories, including a safe harbor for geographic licensees providing commercial service.¹⁸⁴ We seek comment on whether the regulatory renewal framework for WRS commercial geographic licensees is appropriate for NSS licensees. If we apply this framework, are there any special factors we need to account for or incorporate in the context of networks for support of UAS operations?

83. *Competitive bidding or other assignment procedures.* In the event that mutually exclusive license applications are received, we propose to assign these exclusive-use licenses through a system of competitive bidding.¹⁸⁵ Consistent with the competitive bidding procedures the Commission has used in previous auctions, we propose to conduct any auction for geographic area licenses for spectrum in the band in conformity with the part 1, subpart Q general competitive bidding rules, subject to any modification of the part 1 rules that the Commission may adopt in the future.¹⁸⁶ We seek comment on whether any of these rules would be inappropriate or should be modified for an auction of licenses in this band.¹⁸⁷ Our proposal to assign these licenses through competitive bidding assumes that Congress amends section 309(j)(1) of the Communications Act to extend the Commission's authority to award licenses by competitive bidding.¹⁸⁸ We seek comment on alternate assignment procedures in the event that the Commission's statutory authority to auction licenses is not extended.

84. If we provide for the assignment of these licenses through a system of competitive bidding, we also propose to make bidding credits for designated entities available for this band and seek comment on this proposal. If we decide to offer small business bidding credits, we seek comment on how to define a small business. In recent years, for other flexible-use licenses, we have adopted bidding credits for the two larger designated entity business sizes provided in the Commission's part 1 standardized schedule of bidding credits.¹⁸⁹ We propose to use the same definitions here.¹⁹⁰ Accordingly,

¹⁸⁴ See *Amendment of Parts 1, 22, 24, 27, 74, 80, 90, 95, and 101 to Establish Uniform License Renewal, Discontinuance of Operation, and Geographic Partitioning and Spectrum Disaggregation Rules and Policies for Certain Wireless Radio Services*, Second Report and Order and Further Notice of Proposed Rulemaking, 32 FCC Rcd 8874, 8883-85, paras. 20-23 (2017) (*WRS Second R&O*); see also 47 CFR § 1.949. The renewal standard requires that “[a]n applicant for renewal . . . demonstrate that over the course of the license term, the licensee[] provided and continue[s] to provide service to the public, or operated and continue[s] to operate the licensee to meet [its] private, internal communications needs. See 47 CFR § 1.949(d). The safe harbor for geographic licensees providing commercial service requires an applicant for renewal to demonstrate, in part, that it met its performance requirements and continues to provide service at least at the level required by its performance requirements. See 47 CFR § 1.949(e)(2), (3).

¹⁸⁵ See 47 U.S.C. § 309(j)(1).

¹⁸⁶ See 47 CFR §§ 1.2101-1.2114.

¹⁸⁷ Consistent with the statutory requirement and our longstanding approach, we propose to use a public notice process to solicit public input on certain details of auction design and the auction procedures. See 47 U.S.C. § 309(j)(3)(E)(i); *3.5 GHz R&O*, 30 FCC Rcd at 4009, para. 153; *Auction of Priority Access Licenses for the 3550-3650 MHz Band; Comment Sought on Competitive Bidding Procedures for Auction 105; Bidding in Auction 105 Scheduled to Begin June 25, 2020*, AU Docket No. 19-244, Public Notice, 34 FCC Rcd 9215 (2019).

¹⁸⁸ See 47 U.S.C. § 309(j)(1).

¹⁸⁹ See, e.g., *3.7 GHz R&O*, 35 FCC Rcd at 2374-76, paras. 65-68. While the Commission is not required to adopt bidding credits for a particular service, the part 1 rules provide that the Commission may do so by adopting small business or rural service provider bidding credits in the service-specific rules for a band. See 47 CFR § 1.2110(f)(1). Any caps with respect to available bidding credits are adopted on an auction-by-auction basis. *Id.* §§ 1.2110(f)(2)(ii) (cap on designated entity bidding discount), 1.2110(f)(4)(ii) (cap on rural service provider discount).

we propose to define a small business as an entity with average gross revenues for the preceding five years not exceeding \$55 million, and a very small business as an entity with average gross revenues for the preceding five years not exceeding \$20 million.¹⁹¹ A qualifying “small business” would be eligible for a bidding credit of 15 percent and a qualifying “very small business” would be eligible for a bidding credit of 25 percent.¹⁹² We also seek comment on whether the aviation-safety purpose of the band, the characteristics of these frequencies, or any other factor suggest that we should not make available one or either of these designated entity bidding credits, or that we should adopt different small business size standards and associated bidding credits than we have in the past. Finally, we seek comment on whether we should offer rural service providers a designated entity bidding credit for licenses in this band. Commenters addressing these proposals or advocating for any alternatives should consider what specific details of the licenses or operations in the band may affect whether designated entities will apply for them and whether designated entities should be supported by bidding credits.

85. AIA proposes that the Commission directly select NSS licensees from the submitted license applications based on criteria to be established by the FAA or by a multi-stakeholder group to ensure that applicants meet aviation performance levels and minimum performance standards established in RTCA DO-377A.¹⁹³ We seek comment on AIA’s proposal or alternative approaches for selecting the NSS licensees and whether such approaches would be consistent with our statutory obligation under section 309(j) of the Act to use competitive bidding to resolve mutually exclusive applications, and with our general responsibility for licensing of spectrum uses under Title III of the Communications Act.¹⁹⁴

86. Regardless of the assignment mechanism, we seek comment on whether NSS licensees should be subject to a particular limit on the amount of NSS spectrum they can aggregate in the 5030-5091 MHz band, such as a limit of 20 megahertz. To the extent that NSS spectrum is assigned on geographic market basis, are limits on 5030-5091 MHz spectrum aggregation necessary to ensure competition for network-based CNPC services?

87. *Technical requirements.* We seek comment on appropriate technical requirements and parameters for NSS licenses. As an initial matter, the appropriate technical requirements may depend in part on the types of operations likely to be carried out in the band and the network architectures necessary to support such operations. Accordingly, we seek comment on what operations commenters anticipate the NSS licensees will be used to support. Will they include Advanced Air Mobility, package delivery services, or infrastructure inspection? Are they likely to be predominantly operations above, or below, a certain altitude, or to involve predominantly large or predominantly small UA? Will they involve autonomous operations, and if so, to what extent and for what purposes will such autonomous operations likely require network-based CNPC? For those anticipated operations, we seek comment on what type of network architectures will likely be needed in the band to support such uses. Will they necessarily be like

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¹⁹⁰ The standardized schedule of bidding credits provided in section 1.2110(f)(2)(i) of the rules defines small businesses based on average gross revenues for the preceding three years. In December 2018, Congress revised the standard set out in the Small Business Act for categorizing a business concern as a “small business concern,” by changing the annual average gross receipts benchmark from a three-year period to a five-year period. Thus, as a general matter, a federal agency cannot propose to categorize a business concern as a “small business concern” for Small Business Act purposes unless the size of the concern is based on its annual average gross receipts “over a period of not less than 5 years.” 15 U.S.C. § 632(a)(2)(C)(ii)(II), *as amended by* Small Business Runway Extension Act of 2018, Pub. L. 115-324 (Dec. 17, 2018); *see* 13 CFR § 121.903(a)(1)(ii). For consistency with the statutory requirements, we therefore propose to adopt the Small Business Act’s revised five-year average gross receipts benchmark for purposes of determining which entities qualify for small business bidding credits.

¹⁹¹ *See* 47 CFR § 1.2110(f)(2)(i)(B), (C).

¹⁹² *See id.*

¹⁹³ *See AIA Refresh PN Comments at 6; AIA Feb. 1, 2022 Ex Parte, Attach. at 6.*

¹⁹⁴ *See* 47 U.S.C. § 309(j)(1).

the terrestrial cellular networks, or will there be other architectures, and if so, of what nature? To the extent that parties have already developed or plan to deploy network infrastructure to support UAS NSS operations, we seek comment on what type of network architectures they have developed or plan to deploy for this purpose.

88. We seek to adopt technical rules that will promote efficient use of spectrum and provide licensees as much flexibility as possible in terms of the services they wish to provide, while also providing adequate protection of licensees in the band or adjacent bands. We seek comment on requirements that will achieve these goals in the context of spectrum intended to support network-based UAS CNPC with the level of reliability needed for safety-critical aviation purposes. In particular, we seek comment on whether the RTCA DO-362A standard or equivalent technical parameters, which we propose above for NNA operations, should also apply to NSS licenses. Would adopting similar requirements for NSS help to ensure compatibility between NNA and NSS operations? We ask that commenters discuss the adequacy of the RTCA DO-362A specified equipment and operational performance requirements for NSS operations, including both transmitter power and receiver input power, and required minimum coupling loss (separation distance) between ground and airborne CNPC radios and emissions from other licensed radio services. We also seek comment on whether to require NSS licensees to comply with RTCA DO-377A, which addresses the minimum performance, safety, and security standards for a CNPC link system overall, whether that system relies on a network or a direct link.¹⁹⁵ As noted above, AIA recommends that we require UAS equipment to comply with RTCA DO-362A, but leave the requirements in RTCA DO-377A to be considered by the FAA or an appropriate group of stakeholders.¹⁹⁶ We seek comment on whether to take this approach for NSS licensees. To the extent that NSS licensees are permitted to support communications other than CNPC, we seek comment on whether those services should be subject to the same technical requirements as apply to CNPC.

89. Because the RTCA DO-362A standard is focused on point-to-point or point-to-multipoint (i.e., non-networked) link performance rather than network services, and RTCA DO-377A on establishing the minimum performance, security, and safety standards of a system rather than mitigating interference impacts on other systems, we seek comment on whether application of either of these standards sufficiently address the impact of wide area network operations, including cellular networks, on other services in-band or in adjacent bands. We further seek comment on whether applying these standards, or specific parameters drawn from these standards, to network-based services in the band may unnecessarily restrict the range of services or operations in the band. We seek comment on whether there are any additional or alternative technical requirements that we should consider for NSS licenses and on the extent to which communications under these technical requirements would have sufficient reliability for safety-critical aviation purposes. To the extent that parties argue for alternative technical requirements, we ask that they be specific as to what requirements they propose be adopted in the rules.

90. We note that work is ongoing to develop technical standards for reliable UAS communications over mobile networks. For example, RTCA SC-228 is currently working on a joint standard with EUROCAE Working Group 105 “for use of Cellular commercial networks for [command-

¹⁹⁵ See *supra* para. 69; see also, e.g., Wisk *Refresh PN* Comments at 2 n.5 (“DO-377A provides a basis for the safety, performance, and security standards that a CNPC network should meet . . .”).

¹⁹⁶ See AIA *Refresh PN* Comments at 8, 13-14; see also RTCA *Refresh PN* Comments at 7 (recommending that the Commission impose no altitude limits on usage in the 5030-5091 MHz band, but indicating that “[t]he FAA may wish to impose limitations based on the types of UA flight operations” (citing DO-362A, Appx. H and DO-377A, Appx. A)); WInnForum *Refresh PN* Comments at 3 (advocating that the Commission establish rules with “the minimum necessary technical restrictions to provide adequate protection against harmful interference”). Above, we address in greater detail the potential reliance on a multi-stakeholder group to further develop recommendations or standards for UAS or DFMS operations in the 5030-5091 MHz band.

and-control] Links used for type certificated UAS.”¹⁹⁷ CTIA states that the 3rd Generation Partnership Project (3GPP) “is addressing how commercial wireless [Long Term Evolution (LTE)] technologies can satisfy key performance indicators . . . for UAS, and support various UAS use cases.”¹⁹⁸ We seek comment on these efforts, on the scope, status, and anticipated completion date of any other current or planned studies or standards development work regarding the reliability of UAS communications over LTE or other mobile network technologies, and on whether these studies or standards will address or apply to UAS network-based communications in the 5030-5091 MHz band. If not, we seek comment on whether the development of these studies or standards may nevertheless be helpful in determining the appropriate requirements for networks in the 5030-5091 MHz band. We further seek comment on the extent to which any of these studies or standards are being or will be coordinated with the aviation community or the FAA to ensure that they provide sufficient reliability for all UAS use cases, including aviation flights where communications is safety-critical. We also seek comment on the extent to which mobile networks using LTE or other mobile network technologies can be implemented in the 5030-5091 MHz band consistent with the RTCA DO-362A standard.

91. As an alternative to requiring NSS compliance with the RTCA DO-362A standard generally, are there certain specific requirements of RTCA DO-362A that we should minimally impose, to ensure compatibility with NNA operations or for other purposes? For example, as we noted earlier, RTCA asserts that all equipment in the band must comply with the 50 ms Time Division Duplex (TDD) requirements specified under section 2.2.1.3 of the RTCA DO-362A standard to ensure that UAS operations in the band are compatible with each other.¹⁹⁹ We seek comment on whether, even if we do not require general compliance with RTCA DO-362A, we should mandate compliance with the TDD requirements under section 2.2.1.3. Further, we seek comment on whether we should, at a minimum, require NSS equipment to comply with the power limits and out-of-band emission limits established in the standard to ensure that such equipment is compatible with AeroMACS.²⁰⁰

92. We seek comment on any other technical issues that need to be addressed to enable the deployment of NSS networks. For example, in order to prevent harmful interference between geographic area licensees, such licensees are typically subject to market boundary power strength limitations.²⁰¹ Because the networks deployed by geographic area licensees are terrestrial in nature, these limitations were developed using certain technical assumptions—i.e., that natural and manmade terrestrial obstacles attenuate signals, reducing the potential of harmful interference between users in adjacent license service

¹⁹⁷ SC-228 June 2022 Terms of Reference at 5 (indicating a targeted completion date of January 2023); *see also id.* at 2 (indicating that Phase Three of standards development will “[c]onsider new licensed bands that are made available for use for [command-and-control] Links,” including but not limited to “Cellular Networks”), 8 (indicating that the new document will “enable a common standard for avionics using standardized cellular services offered worldwide”).

¹⁹⁸ CTIA *Refresh PN* Comments at 11; *see also id.* at 13 (“Allowing the commercial mobile industry to continue working with standards-setting bodies such as 3GPP to develop standards to support UAS will be an effective and efficient approach to the expeditious development of UAS wireless standards that can be deployed, nationwide and worldwide.”). The 3rd Generation Partnership Project (3GPP) is an umbrella organization consisting of standards organizations that develop protocols for cellular telecommunications, including the Long-Term Evolution standard (LTE). *See* 3GPP, *About 3GPP*, <https://www.3gpp.org/about-3gpp> (last visited Sept. 6, 2022).

¹⁹⁹ *See* RTCA *Refresh PN* Comments at 6; *see also* AIA *Refresh PN* Comments at 11 (supporting a requirement that transmitters comply with the 50 ms TDD requirements of RTCA DO-362A § 2.2.1.3).

²⁰⁰ *See, e.g.,* L3H *Refresh PN* Comments at 10 (“The Output Power restrictions identified RTCA DO-362A § 2.2.1.6.1.1 & 2.2.1.6.1.2 in addition to the C Band Airborne Radio Transmitter PSD Limits specified in RTCA DO-362A § 2.2.1.6.2 should protect AeroMACS from potentially harmful interference from UAS.”); *see also* RTCA DO-377A at § 3.3.1.2 (“Based on the analysis in DO-362A . . . , the use of C-Band CNPC LOS radios of the C2 Link for surface operations will be compatible with AeroMACS in airports where AeroMACS is available.”).

²⁰¹ *See* 47 CFR § 27.55.

areas.²⁰² Obstacles such as hills, trees, buildings, and other natural and manmade structures attenuate emissions, lessening the interference impact between licensees. UAS operations typically fly above many of these obstacles and, depending on the UA altitude and its distance to the service area boundary border, a UA may be in direct line-of-sight with adjacent license areas and users, greatly increasing the potential for harmful interference. As we anticipate adopting geographic area-based licenses for NSS spectrum, we request comment on an appropriate field strength limit to protect NSS licensees given this increased potential for harmful interference. We seek comment on other necessary technical specifications, such as out-of-band emission limits, and ask that any proposals include technical justifications and analysis, such as UA altitude assumptions, power levels, antenna assumptions, the increasing interference effects resulting from the increasing number of transmitting UA (aggregate effects), and the victim receiver characteristics such as receiver sensitivity, and adjacent and non-adjacent channel rejection.

93. *Application of requirements from aviation service and wireless radio service rules.* As with NNA service rules above, we seek comment on whether and to what extent the NSS service rules should incorporate or be subject to the rules generally applicable to aviation services under subparts B through F of part 87 of the Commission's rules, either in their current form or with modifications.²⁰³ We also seek comment on whether the NSS service should be subject to rules under part 1, subpart F governing Wireless Radio Service applications and proceedings.²⁰⁴ In particular, we seek comment on whether to allow partitioning and disaggregation of NSS licenses in secondary market transactions as well as spectrum leasing, including whether we should consider any competitive impacts associated with such transactions.²⁰⁵ Allowing these secondary market transactions would be consistent with the licensing paradigm governing most geographic area licenses and are potentially an effective way to improve spectral efficiency and facilitate targeted network deployments, particularly if the Commission adopts a long license term or large license area. We seek comment on whether these factors support application of the full range of secondary market options to 5030-5091 MHz NSS licensees, or if secondary market rules should either be more restrictive or completely inapplicable due to special considerations of the 5030-5091 MHz band.

94. We anticipate that NSS licenses will be used to provide mobile network services to UAS operators on a commercial basis. Accordingly, we also seek comment on whether and to what extent we should incorporate regulations that regulate commercial mobile networks in other bands, such as the requirements generally applicable to part 27 flexible-use licensees. For example, should we incorporate or apply the requirements of sections 27.52 (RF safety), 27.56 (antenna structure height for the protection of air safety), or 27.64 (protection from interference)?²⁰⁶

95. *Other requirements.* We seek comment on any other service rules we should adopt for NSS licensees. For example, to ensure that UA flights are supported in the event they need to cross license area boundaries, should we adopt a roaming requirement? If anything more than market forces is necessary to address this issue, should the current roaming requirements under section 20.12(e) of the Commission's rules, requiring commercial mobile data service providers to offer roaming arrangements to other such providers on commercially reasonable terms and conditions, be extended to NSS licensees

²⁰² For example, geographic area licensees' service area power limits in sections 22.913(b) and 27.55(d) and (e) of the Commission's rules are measured at a height 1.6 meters above ground level to estimate the height of a mobile (UE) taking into account terrain obstacles. See 47 CFR §§ 22.913(b), 27.55(d), (e).

²⁰³ See 47 CFR pt. 87, subpts. B (Applications and Licenses), C (Operating Requirements and Procedures), D (Technical Requirements), E (Frequencies), F (Aircraft Stations).

²⁰⁴ See 47 CFR pt. 1, subpt. F (Wireless Radio Services Applications and Proceedings). The term "Wireless Radio Services" is currently defined as "[a]ll radio services authorized in parts 13, 20, 22, 24, 26, 27, 30, 74, 80, 87, 90, 95, 96, 97 and 101 of this chapter, whether commercial or private in nature." 47 CFR § 1.907.

²⁰⁵ See 47 CFR pt. 1, subpt. X (spectrum leasing), § 1.950 (partitioning and disaggregation).

²⁰⁶ See 47 CFR §§ 27.52, 27.56, 27.64.

for this purpose?²⁰⁷ If these requirements are sufficient, how and where should we integrate them in the context of NSS service rules? If they are insufficient, what additional rules are needed to ensure that UAS operate continually and safely across licensing areas? We also seek comment on whether to adopt an interoperability requirement, for example, requiring NSS equipment to be capable of operating over any part of the 5030-5091 MHz band dedicated to NSS operations, or requiring support for the entire band. We further seek comment on whether to impose requirements to enable seamless switching between NNA and NSS services to support flights that may need to rely on both modes of spectrum access. Should we require NSS licensees to provide any other information, including the manufacturer, model, or other details regarding the UAs that will be flown? We seek comment on any requirements or other measures that would promote intensive use of the band. For example, we seek comment on how we might facilitate use of NSS for both low and high altitude uses, and whether we should require NSS licensees to support both low and high altitude uses or should take other steps to ensure that both low and high uses are supported.

96. *Satellite-based networks.* As discussed above, the 5030-5091 MHz band is allocated internationally and domestically for AMS(R)S, which would support the provision of CNPC services over satellite. AIA's petition for rulemaking, however, did not request or propose that any provision be made for satellite services in the band, and no party in the current record has proposed such an option.²⁰⁸ It also appears that RTCA's work on CNPC MOPS in the 5030-5091 MHz band has, up to now, largely focused on terrestrial rather than satellite services in the band.²⁰⁹ We nevertheless seek comment on whether to authorize NSS licensees, at their discretion, to provide network-supported service for UAS CNPC through either a satellite or terrestrial network, or alternatively, whether the Commission should provide that certain NSS licenses are dedicated exclusively to satellite-based service.²¹⁰ We seek comment on whether and to what extent there is interest in the United States in providing a satellite service for CNPC in the 5030-5091 MHz band, on the costs and benefits of permitting NSS licensees to deploy satellite services for network-supported CNPC, and on the advantages and disadvantages of a satellite option over terrestrial networks in this context. For example, would satellite be a feasible and desirable means of deploying a CNPC-focused network with the ubiquitous coverage needed to support long-range operations, particularly those operations that may occur in remote areas and over oceanic regions or other large bodies of water?

97. Assuming we permit NSS licensees to deploy satellite-based service, we seek comment on how to permit and integrate the provision of such services and on the appropriate service rules. We seek comment on the application of the Commission's part 25 rules, which govern satellite communications, to such services, and the extent to which the rules applicable to terrestrial NSS networks

²⁰⁷ See 47 CFR § 20.12(e).

²⁰⁸ See, e.g., AIA *Refresh PN* Comments at 13 (stating the licensees in spectrum for network service will be “[t]errestrial station owners”); see also *id.* at 5 (distinguishing between beyond-line-of-sight operations in the past, which were based on satellite-support, and “the future of terrestrial CNPC links” that would involve “multiple, remote [Ground Radio Stations] on a network providing long-range, continuous C2 link coverage and remote operation, without reliance on or the disadvantages of satellite communications links.”); RTCA *Refresh PN* Comments at 8 (asserting that the Ku and Ka fixed satellite services bands are already being considered for CNPC links and have significant capacity).

²⁰⁹ While the RTCA DO-362A MOPS focuses on “a ‘terrestrial’ based (i.e., not satellite-based) CNPC Link System” in the 5030-5091 MHz band, see RTCA DO-362A, § 1.1, it also includes discussion of a satellite system design compatible with the terrestrial system in an Appendix. See RTCA DO-362A, Appx. G (C Band Satellite Link Compatibility). In addition, the Terms of Reference for SC-228 (Rev 15) dated June 23, 2022, indicates that a planned update of RTCA DO-362A, to be designated DO-362B, will “[i]ncorporate changes required to harmonize SATCOM compatibility with EUROCAE Standard.” See SC-228 June 2022 Terms of Reference at 5.

²¹⁰ See also *supra* section B.1 (Band Plan) (seeking comment on preserving a portion of the band for satellite CNPC).

should also apply to satellite-based NSS networks. We further seek comment on how the DFMS and other proposals discussed above would work for satellite communications. For example, how would a DFMS implement opportunistic access to spectrum in which satellite operations might be deployed? We also seek comment on how to ensure that any such satellite services are compatible with both terrestrial NSS and NNA operations in the band and other in-band and adjacent-band services, and on the circumstances, requirements, coordination processes, and/or restrictions necessary to ensure compatibility and to provide the reliability intended for CNPC in this band. For example, should we permit an NSS licensee to deploy a satellite service only if the NSS license is nationwide or the licensee in question has aggregated all geographic area licenses in a particular block throughout the nation? Are guard bands necessary between blocks with satellite deployments and blocks used for terrestrial networks or operations? Footnote 5.443D of the Table of Frequency Allocations provides that services under the satellite allocation in the 5030-5091 MHz band are subject to coordination under ITU Radio Regulations (R.R.) No. 9.11A, and that the use of this frequency band by the AMS(R)S is limited to internationally standardized aeronautical systems.²¹¹ We seek comment on what rules, if any, we should adopt to implement the requirements under footnote 5.443D.

98. *High-Altitude Platform Stations.* We seek comment on whether to permit NSS licensees to deploy High-altitude Platform Stations (HAPS). The Commission's rules define a "High Altitude Platform Station" as "[a] station located on an object at an altitude of 20 to 50 km and at a specified, nominal, fixed point relative to the Earth."²¹² Potentially, these stations could be used by NSS licensees as a long-range relay of CNPC between two or more stations, and RTCA DO-362A includes extensive analysis of such an option, which it refers to as a "High-altitude Relay System."²¹³ We seek comment on whether and to what extent there is current interest in deploying HAPS as all or part of a network solution for CNPC, on the technical feasibility and commercial viability of the use of HAPS to provide all or part of a network service in the 5030-5091 MHz band, and on the costs and benefits of permitting HAPS for this purpose.²¹⁴ To the extent it is feasible and economic, are there limitations on the circumstances or uses to which it can be applied? For example, would it be available only to provide relay between two or more UA, or could it also provide relay between UA and stations on the ground? We also seek comment on what technical or other requirements or restrictions are needed either to ensure that NSS use of HAPS to provide network service would be compatible with other operations and services or for other reasons. For example, we seek comment on whether, consistent with the definition of HAPS in the Commission's

²¹¹ See 47 CFR § 2.106, footnote 5.443D. ITU R.R. No. 9.11A provides that "for a station for which the requirements to coordinate is included in a footnote to the Table of Frequency Allocations referring to this provision, the provisions of Nos. 9.12 to 9.16 are applicable." ITU R.R. No. 9.11A. ITU R.R. No. 9.6 in turn provides that "[b]efore an administration notifies to the Bureau or brings into use a frequency assignment in any of the cases listed below [including the cases covered by 9.11A], it shall effect coordination, as required, with other administrations identified under No. 9.27." ITU R.R. No. 9.6.

²¹² 47 CFR § 2.1(c); see also ITU R.R. No. 1.66A.

²¹³ See, e.g., RTCA DO-362A, Appx. U (C Band High Altitude Relay System). In its comment, RTCA refers to this option as a "High-Altitude Platform/Relay System." RTCA *Refresh PN* Comments at 5.

²¹⁴ The record does not reflect any current interest in using HAPS for the provision of network-based CNPC in the band. In comments submitted in 2018 in response to the AIA Petition, the Elefante Group did indicate that it planned to deploy what it described as "persistent, unmanned stratospheric airborne platforms ('STRAPS') . . . to provide stratospheric-based communications service," and that it was interested in using direct links in the 5030-5091 MHz band for command-and-control "[d]uring ascent and descent" of the stations. Elefante Group *AIA Petition* Comments at 1-2. Once in place, however, the stations were intended to provide "5G solutions in urban and rural markets" rather than CNPC services in the 5030-5091 MHz band. *Id.* In a subsequent filing in another proceeding, the Elefante Group further indicated, in regard to its plans to deploy STRAPS, that due to "unforeseen developments," it was "unable to state with certainty its ability at this time to" deploy these platforms. See Elefante Group Comments, WT Docket No. 20-133, at 2 (filed Aug. 5, 2020).

rules, we should specify an altitude floor and/or ceiling on the use of such stations.²¹⁵ Given the potential footprint of a HAPS-based service, should we permit an NSS licensee to deploy HAPS only if the NSS licensee holds a nationwide market or holds all geographic area licenses on a particular block nationwide? We further seek comment on whether permitting such systems warrants any revisions to the proposals or options for the NSS rules. In addition, because the HAPS acting as network relays for UA communications would also themselves be UA, we seek comment on whether an NSS licensee's operation of such stations may require CNPC (during ascent, descent, or otherwise), whether and to what extent such stations should be permitted to use NNA assignments for CNPC, and if so, what changes to our NNA proposals or other rules are needed.²¹⁶ We note that No. 4.23 of the ITU Radio Regulations provides that “[t]ransmissions to or from high altitude platform stations shall be limited to bands specifically identified in Article 5 (WRC-12).”²¹⁷ At present, Article 5 does not specifically identify the 5030-5091 MHz band for this purpose.²¹⁸ We seek comment on whether, if we restricted such stations to deployments below the 20 km floor for HAPS as defined in the ITU Radio Regulations, permitting HAPS in the band could nonetheless be consistent with No. 4.23 or if, to permit such use, we would need to seek a revision to the bands in which HAPS is permitted under ITU R.R., Article V. We seek comment on whether there is any other legal constraint or consideration to address in permitting such use.

8. Equipment Authorization

99. To ensure that equipment in the new band has the level of reliability and safety required of aviation equipment, we propose to impose equipment authorization requirements similar to those under sections 87.145 and 87.147 of the Commission's rules to all equipment intended for use in the 5030-5091 MHz band. Section 87.145 requires that each transmitter must be certificated for use in the relevant service, and section 87.147 establishes a specific equipment authorization process for part 87 equipment, which, for the frequencies in the 5030-5091 MHz band among others, requires coordination with the FAA.²¹⁹ We note that 5030-5091 MHz UAS radio equipment must independently satisfy any applicable FAA requirements,²²⁰ and we anticipate that this coordination process will ensure that the 5030-5091 MHz equipment authorizations by the Commission and the FAA are consistent and that all equipment approved for use in the band will meet both agencies' requirements. We seek comment on our proposals.

²¹⁵ 47 CFR § 2.1(c).

²¹⁶ RTCA asserts that the necessary duration of an assignment to support such HAPS relays may be significantly longer than assignments for other types of UA flights. *See RTCA Refresh PN Comments* at 5 (asserting that because the HAPS relay scenario will involve a UA that “loiters for months at altitude > 60Kft., the ‘end of flight’ would be much longer after the beginning of the flight than for non-[HAPS] flights” and that “[c]ontinuous usage of the spectrum would be needed throughout the flight to support internal control messages being sent to/from the [HAPS] UA”).

²¹⁷ ITU R.R. No. 4.23.

²¹⁸ Article V of the ITU Radio Regulations reflects the frequency allocation decisions made by the World Radio Councils (WRC) to date. *See* ITU R.R., Article V; *see also* 47 CFR § 2.106. At three WRCs collectively (WRC-97, WRC-200, and WRC-12), spectrum for HAPS was designated in the 47/48 GHz, 2 GHz, 27/31 GHz and 6 GHz bands, and after study for WRC-19, additional spectrum was identified: 31-31.3 GHz and 38-39.5 GHz globally, and in Region 2 (including US), 21.4-22 GHz and 24.25-27.5 GHz. *See Wireless Telecommunications Bureau Seeks to Supplement the Record on 70/80/90 GHz Bands Notice of Proposed Rulemaking*, WT Docket No. 20-133, Public Notice, DA 21-1263, n.15 (WTB Oct. 8, 2021).

²¹⁹ *See* 47 CFR §§ 87.145(a), 87.147(d).

²²⁰ *See, e.g.*, TSO-C213a.

9. Protection of Other Services

a. Microwave Landing Systems

100. The Microwave Landing System (MLS) is a radio guidance system that was intended to be installed at airports to aid aircraft in landing when, e.g., the airports are visually obscured by bad weather, and that provided certain technical improvements over the original Instrument Landing System.²²¹ Footnote 5.444 of the Table of Frequency Allocations provides that in the band 5030-5150 MHz, the requirements of MLS have priority over other uses of this frequency band.²²²

101. These systems were rendered obsolete by more recent instrument-landing solutions, including GPS-based solutions like the Wide Area Augmentation System, and a search of ULS reveals no active MLS in use by non-federal licensees.²²³ Further, according to NTIA's most recent summary of federal use of the 5030-5250 MHz band, "[t]he FAA does not anticipate utilizing MLS installations at airports."²²⁴ NTIA also notes, however, that "[t]he Air Force has a number of assignments in the 5030-5091 MHz band for a transportable version of the MLS, an all-weather precision landing system for tactical purposes and has installed these systems at several Air Force bases."²²⁵ It states that "the Air Force will continue to use MLS into the foreseeable future in order to provide landing guidance to military aircraft."²²⁶

102. We seek comment on what measures we should adopt to protect federal MLS services from harmful interference by UAS communications in the 5030-5091 MHz band. Should we establish exclusion zones around the Air Force bases with MLS deployments, with a process to add or eliminate exclusion zones to the extent federal MLS stations are deployed or deactivated? AIA proposes that the Commission codify the locations at which MLS operations are conducted and establish a coordination mechanism to enable UAS CNPC operations near those MLS stations.²²⁷ We seek comment on this option, the specifics of any such coordination mechanism, and how this or any option would address the deployment of new federal MLS stations, particularly in the case of NSS licensees that may have already deployed networks in the area of the new deployment.

103. Because we find no current licensed non-federal MLS systems in operation, and given that the FAA does not anticipate the future use of these systems at airports, we seek comment on whether any measures are necessary to protect non-federal MLS. We also seek comment on whether to provide that no future non-federal MLS licenses (including MLS radionavigation land test licenses at 5031 MHz) will be granted in the 5030-5091 MHz band by amending sections 87.173(b) and 87.475 of our part 87

²²¹ See *Section 374 Report* at 5.

²²² See 47 CFR § 2.106, footnote 5.444; see also 47 CFR § 87.173(b) (authorizing MLS over the frequencies 5030-5150 MHz). The rules also permit deployment of "radionavigation land test" stations at 5031 MHz but only for the testing of MLS airborne receiving equipment. See 47 CFR § 87.475(c)(2).

²²³ See *Section 374 Report* at 5 (stating the systems are obsolete and "no longer in use"); FCC, *Advanced License Search*, <https://wireless2.fcc.gov/UlsApp/UlsSearch/searchAdvanced.jsp> (search restricted to frequency range of 5030 and 5091 MHz); see also NTIA Spectrum Compendium, 5030-5250 MHz, Feb. 2021, at 11, <https://www.ntia.doc.gov/files/ntia/publications/compendium/5030.00-5250.00-02092021.pdf> (NTIA Spectrum Compendium (5030-5025 MHz)).

²²⁴ NTIA Spectrum Compendium (5030-5025) at 11.

²²⁵ *Id.* at 9.

²²⁶ *Id.* at 11.

²²⁷ See AIA Petition at 18; see also AURA AIA Petition Comments at 6; Boeing AIA Petition Comments at 11; Lockheed Martin AIA Petition Comments at 4-5.

rules to remove the 5030-5091 MHz band as a band that can be used for non-federal MLS.²²⁸ We seek comment on the costs and benefits of this option. Would eliminating the potential for future non-federal MLS in the 5030-5091 MHz band help to ensure a stable spectral environment that may facilitate the use of the band for UAS CNPC? Would it facilitate the use of the band for other communications, to the extent such communications may be permitted? Given the development and widespread adoption of alternative solutions for instrument-based landing and the apparent abandonment of MLS, is there any need to preserve the option in our rules for licensing of non-federal MLS in this band?

b. Out-of-band Services

104. *Radioastronomy.* Footnote US211 of the Table of Frequency Allocations currently provides that in a number of frequency bands that includes the 5000-5250 MHz band, “applicants for airborne or space station assignments are urged to take all practicable steps to protect radio astronomy observations in the adjacent bands from harmful interference[.]”²²⁹ To address the potential impact on radio astronomy observations from UAS transmissions in the 5030-5091 MHz band, NTIA requests that Footnote US211 continue to apply to any services authorized in the 5030-5091 MHz band.²³⁰ NTIA also recommends that the Commission require coordination of UAS operations within the National Radio Quiet Zone (NRQZ).²³¹ NTIA further recommends that “additional criteria” be developed to minimize UAS impact to particular radio astronomy sites, particularly from low-altitude operations, but does not elaborate or propose particular criteria.²³² As a further measure, NTIA recommends that the requirements for licensees in the band include passing a test or similar effort to promote awareness of radio astronomy sites.²³³

105. We seek comment on whether additional measures are necessary to protect radio astronomy and on NTIA’s recommendations in this regard. We propose, consistent with NTIA’s recommendations, to continue to apply the requirements of Footnote US211 in the 5030-5091 MHz band, to prohibit UAS operations within the NRQZ without prior coordination with the NRQZ administrator and, in the case of NNA operations relying on DFMS assignments, to require the submission of a concurrence from the NRQZ administrator with any request to a DFMS for frequency assignment within the NRQZ. We seek comment on these proposals. We note that section 1.924(a) of the Commission’s rules establishes required procedures for licensees and applicants that seek to construct or operate new or modified fixed stations to coordinate their deployments in the NRQZ.²³⁴ Should we apply these

²²⁸ We note that removing the frequencies for non-federal MLS operations from our service rules would not affect federal authority to utilize the band for MLS, or the need to protect such services.

²²⁹ See 47 CFR § 2.106, footnote US211. For certain of these bands, the obligation is limited by Footnote US74, which provides that in the specified bands, the radio astronomy service shall be protected from unwanted emissions only to the extent that such radiation exceeds the level which would be present if the offending station were operating in compliance with the technical standards or criteria applicable to the service in which it operates. See 47 CFR § 2.106, footnote US74. The 5030-5091 MHz band, however, is not one of the bands to which Footnote US74 applies. *Id.*

²³⁰ See NTIA Refresh PN Reply at 1.

²³¹ See NTIA Refresh PN Comments at 2. The National Radio Quiet Zone (NRQZ) is a fixed 13,000 square mile rectangular area that covers portions of Virginia, West Virginia, and Maryland and that provides interference protection to radio astronomy operations of the National Radio Astronomy Observatory at Green Bank, West Virginia, and the Naval Radio Research Observatory at Sugar Grove, West Virginia. See, e.g., 47 CFR §§ 1.924(a), 97.3(a)(33); *Service Rules for Advanced Wireless Services in the 1.7 GHz and 2.1 GHz Bands*, WT Docket 02-353, Report and Order, 18 FCC Rcd 25162, 25175, para. 34 (2003).

²³² See NTIA Refresh PN Reply at 2.

²³³ See *id.*

²³⁴ See 47 CFR § 1.924(a) (establishing procedures for the NRQZ).

licensee/applicant procedures for the NRQZ to all UAS operations relying on the 5030-5091 MHz band in the NRQZ? To the extent we require NRQZ administrator concurrence for licensed-by-rule operations, we seek comment on the appropriate procedures to apply. To the extent measures beyond coordination and concurrence requirements for UAS operations are warranted, we seek comment on what other measures are practicable.

106. *AeroMACS*. AeroMACS is a broadband aeronautical mobile (route) service system that will enable communications for surface operations at airports between aircraft and other vehicles and between other critical fixed assets.²³⁵ The Commission has allocated both the 5000-5030 MHz and 5091-5150 MHz bands for such use but has not yet established service rules in either band.²³⁶

107. We seek comment on whether any special measures are necessary to ensure compatibility between UAS operations in the 5030-5091 MHz band and AeroMACS. AIA indicates that RTCA is currently working on a revision to the AeroMACS technical standard, RTCA DO-346, that will ensure that future AeroMACS deployments will be compatible with CNPC links that are in compliance with RTCA DO-362A, and that no other special limitations on 5030-5091 MHz operations beyond compliance with RTCA DO-362A are necessary.²³⁷ More recently, RTCA's Program Management Committee (PMC) held its June 2022 meeting approving RTCA DO-346A with these revisions.²³⁸ We seek comment on whether the revised AeroMACS standard and compliance with the power and out-of-band emission limits of RTCA DO-362A are adequate measures to protect AeroMACS operations from harmful interference from 5030-5091 MHz UAS operations, and whether the revisions to the AeroMACS standard require specific service rules for the 5030-5091 MHz band. Should we adopt exclusion zones around airports with AeroMACS deployments, or prohibit use of a certain amount of spectrum at the edge of the 5030-5091 MHz band in the vicinity of such airports?

108. *Radionavigation-satellite service*. The 5010-5030 MHz band also includes an allocation for the radionavigation-satellite service (RNSS) (space-to-Earth) for potential future use.²³⁹ Footnote 5.443C of the Table of Frequency Allocations addresses requirements in the 5030-5091 MHz band for the protection of RNSS downlinks.²⁴⁰ Specifically, it provides that “[u]nwanted emissions from the

²³⁵ See *Amendment of the Commission's Rules to Promote Aviation Safety et al.*, WT Docket No. 19-140 et al., Notice of Proposed Rulemaking, 34 FCC Rcd 4984, 4997, para. 34 (2019) (*Aviation NPRM*).

²³⁶ See *id.* at 4997, para. 35.

²³⁷ See AIA *Refresh PN* Comments at 11 (stating that RTCA is acting on a adjacent channel protections and recommends that no special limitation on 5030-5091 MHz operations are necessary to protect future AeroMACS deployments); see also L3H *Refresh PN* Comments at 10 (asserting that 5030-5091 MHz service compliance with the power restrictions and power spectral density limits in RTCA DO-362A should protect AeroMACS from harmful interference from UAS); RTCA *Refresh PN* Comments at 7 (stating that agreements are in the final implementation stages among RTCA special committees to modify the AeroMACS MOPS so that AeroMACS systems “are compatible with DO-362A compliant CNPC radios that operate in the 5030-5091 MHz band”); Wisk *Refresh PN* Comments at 5 (asserting that AeroMACS standard revision “will address the adjacent band compatibility requirements and FCC service rules can be based on or refer to this standard for a adjacent band interference limits”); RTCA DO-377A, § 3.3.1.2 (“Based on the analysis in DO-362A . . . , the use of C-Band CNPC LOS radios for the C2 Link for surface operations will be compatible with AeroMACS in airports where AeroMACS service is available. It is understood that there will be an update to the AeroMACS radios, which will ensure that all AeroMACS airborne and ground radios emissions will not degrade the C Band C2 Link.”); see also RTCA DO-362A, Appx. T at T.3 (specifying spatial separation, antenna orientations, and filtering criteria to protect AeroMACS operations).

²³⁸ See <https://www.rtca.org/news/standards-oversight-committee-acts-on-emerging-technologies-and-safety-oversight-2/>.

²³⁹ See 47 CFR § 2.106.

²⁴⁰ See 47 CFR § 2.106, footnote 5.443C.

aeronautical mobile (R) service in the frequency band 5030-5091 MHz shall be limited to protect RNSS system downlinks in the adjacent 5010-5030 MHz band” and that “[u]ntil such time that an appropriate value is established in a relevant ITU-R Recommendation, the e.i.r.p. density limit of -75 dBW/MHz in the frequency band 5010-5030 MHz for any AM(R)S station unwanted emission should be used.”²⁴¹ As CNPC services would be part of the AM(R)S allocation, this requirement applies to such services in the 5030-5091 MHz band. We propose to require 5030-5091 MHz operations to comply with the specific EIRP spectral density limit specified in Footnote 5.443C and seek comment on that proposal. Footnote 5.443C further limits AM(R)S use of the 5030-5091 MHz band to “internationally standardized aeronautical systems.”²⁴² We seek comment on codifying this requirement as a service rule and on whether any other measure is necessary to implement the restriction. We further seek comment on whether any other special measures applicable to the 5030-5091 MHz band, such as a guard band at the bottom edge of the 5030-5091 MHz band, should be adopted to protect RNSS system downlinks.²⁴³

109. *Flight testing.* The 5091-5150 MHz band is also allocated for aeronautical mobile telemetry communications from aircraft stations, subject to the technical parameters in ITU Resolution 418 (WRC-12) intended to ensure compatibility with other services.²⁴⁴ According to NTIA, federal agencies currently use this allocation in the 5091-5150 MHz band to support flight testing.²⁴⁵ We seek comment on whether measures beyond generally applicable out-of-band emissions limits are necessary to ensure that 5030-5091 MHz operations are compatible with such services.

c. Canadian and Mexican Coordination

110. International agreements with Mexico and Canada do not address the use of the 5030-5091 MHz band for UAS communications.²⁴⁶ In the event of any adjustments made to the agreements with Mexico or Canada regarding use of the 5030-5091 MHz band, we note that our proposed rules, and any rules that may ultimately become effective pursuant to this proceeding, may need to be modified to comply with those agreements. We seek comment on whether we should adopt an interim measure to address UAS communications in the 5030-5091 MHz band that may cause harmful interference to operations in Mexico or Canada during the period prior to any adjustments made to the agreements between the United States, Mexico, and/or Canada regarding use of the band. If so, what should this interim measure provide?

III. AIRBORNE USE OF FLEXIBLE-USE SPECTRUM

111. Beyond the development of the 5030-5091 MHz band for UAS operations, the use of flexible-use spectrum²⁴⁷ and existing networks as platforms for UAS offers promise because these

²⁴¹ See *id.* Section 3 of the RTCA DO-362A standard requires the use of the EIRP density limit of -75 dBW/MHz as specified in Footnote 5.443C. See RTCA DO-362A § 3.2.1.4.6; see also *id.*, Appx. T: Protecting Adjacent Band Systems Against Interference From Terrestrial C Band CNPC Links, at T.4.

²⁴² 47 CFR § 2.106, footnote 5.443C.

²⁴³ See also *supra* para 18. We note that Appendix T of RTCA DO-362A includes an analysis of the maximum allowable power spectral density (PSD) for UAS ground radio stations (GRS) and airborne radio stations (ARS) required to protect RNSS systems. See RTCA DO-362A, Appx. T.

²⁴⁴ 47 CFR § 2.106, footnote US444B (referencing ITU R.R., Resolution 418 (Rev. WRC-12), titled “Use of the band 5091-5250 MHz by the aeronautical mobile service for telemetry applications”).

²⁴⁵ See NTIA Spectrum Compendium (5030-5025 MHz) at 1, 9.

²⁴⁶ See FCC, *Canadian Agreements by Frequency*, <https://www.fcc.gov/canadian-agreements-frequency>; (last visited Sept. 6, 2022); FCC, *Mexican Agreements by Frequency*, <https://www.fcc.gov/mexican-agreements-frequency>. (last visited Sept. 6, 2022).

²⁴⁷ The term “flexible-use spectrum” or “flexible-use bands,” refers to services or spectrum bands for which the Commission’s rules do not prescribe specific uses or applications.

existing networks provide significant coverage with low latency, high throughput, and dedicated and secure communications. The use of such existing infrastructure may provide the added benefit of a near-term, low-cost option in comparison to building a dedicated network for UAS operations.

112. There is considerable interest in using existing terrestrial mobile networks for UAS communications, including command and control, telemetry, and payload communications. Because these networks were not designed for UAS use, however, the integration of UAS into terrestrial mobile networks may not be a seamless transition. The Commission's terrestrial mobile service rules generally do not consider airborne use, and whether within a network or across adjacent networks, the potential for increased interference is probable when UAS are introduced.

113. While the Commission remains committed to allowing flexibility in the use of existing spectrum and networks, we are uncertain about the potential interference impacts of UAS use. Therefore, we seek comment on the adequacy of current rules to ensure co-existence of existing terrestrial wireless networks and UAS and on the regulatory solutions that may be necessary to facilitate and encourage such use. Our action is consistent with WTB and OET's recommendation in the *Section 374 Report* to conduct further review of the flexible-use bands for UAS.²⁴⁸

A. Background

114. Federal agencies, industry stakeholders, and standards bodies have undertaken significant work to facilitate use of UAS, including development of flexible-use spectrum as a platform. As interest in and demand for UAS services grows, this initial work will form the foundation for the additional research and testing that is necessary to evaluate the need for further regulatory action by the Commission, where appropriate.

115. *FAA Programs.* As noted, the FAA has engaged in a variety of initiatives to safely integrate UAS into the National Airspace System, some of which considered the use of various spectrum bands as platforms for UAS. Among these initiatives, in 2017, the FAA established the UAS Integration Pilot Program (IPP) to permit state, local, and Tribal governments to partner with private sector entities, such as UAS operators or manufacturers, to accelerate safe UAS integration.²⁴⁹ IPP participants evaluated several operational concepts, including night-time operations, flights over people and beyond-visual-line-of-sight operations, package delivery, detect-and-avoid technologies, and link reliability.²⁵⁰ The IPP program concluded in October 2020 after which the FAA launched a new program called BEYOND, which is intended to continue the work of UAS integration.²⁵¹ The FAA also chartered the Unmanned Aircraft Systems Beyond Visual Line-of-Sight Operations Aviation Rulemaking Committee (BVLOS ARC) in June 2021 to review insights gained from these and other activities and to provide recommendations regarding performance-based regulatory requirements that will enable the integration of beyond-visual-line-of-sight operations in the National Airspace System.²⁵² In March 2022, the BVLOS ARC issued a Final Report, making over 70 recommendations regarding regulatory changes to facilitate such operations.²⁵³ The BVLOS ARC Final Report noted that “[r]eliable and continuous access to

²⁴⁸ *Section 374 Report*, at 1.

²⁴⁹ See FAA, UAS Integration Pilot Program, https://www.faa.gov/uas/programs_partnerships/completed/integration_pilot_program/ (last visited Sept. 6, 2022).

²⁵⁰ *Id.*

²⁵¹ See FAA, BEYOND, https://www.faa.gov/uas/programs_partnerships/beyond/ (last visited Sept. 6, 2022). As part of the BEYOND program, the FAA is continuing its partnerships with eight of the nine IPP participants, which continue to test and refine varying UAS operational concepts. *Id.*

²⁵² U.S. Department of Transportation, Federal Aviation Administration, Aviation Rulemaking Committee Charter, UAS Beyond Visual Line-of-Sight Operations Aviation Rulemaking Committee (June 8, 2021).

spectrum is essential to the continued growth of the UAS industry” and that it is critical for all available communications technology to be enabled.²⁵⁴

116. *Stakeholder Interest in UAS on Flexible-Use Spectrum.* Manufacturers, service providers, and public and private UAS operators support using a wide range of bands for UAS operations in addition to spectrum bands dedicated to aeronautical use,²⁵⁵ and research is underway to study the potential of flexible-use spectrum for UAS uses. For example, in accordance with its Part 5 Program Experimental Radio License rules, the Commission in August 2021 approved the North Carolina State University Innovation Zone²⁵⁶ for use by the Aerial Experimentation and Research Platform for Advanced Wireless (AERPAW).²⁵⁷ The AERPAW testbed is the first research platform to study the use of 5G wireless technology as a platform for UAS.²⁵⁸ Several mobile service providers and other stakeholders currently are developing network-based UAS applications that would operate over commercial networks using flexible-use spectrum²⁵⁹ and are testing UAS operations on their networks for interference and other performance issues.²⁶⁰ Verizon, for example, has stated that it is “actively testing how the use of its commercial mobile network to support drone deployments affects its own networks, neighboring licensees in adjacent geographies, and neighboring licensees in adjacent bands to ensure the avoidance of harmful interference.”²⁶¹ To this end, Verizon—through its subsidiary Skyward—and the FAA have

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²⁵³ See generally Unmanned Aircraft Systems Beyond Visual Line of Sight Aviation Rulemaking Committee, *Final Report* (March 10, 2022) (*BVLOS ARC Final Report*) https://www.faa.gov/regulations_policies/rulemaking/committees/documents/media/UAS_BVLOS_ARC_FINAL_REPORT_03102022.pdf.

²⁵⁴ *Id.* at 61.

²⁵⁵ See Airbus UM *Section 374 Report* Comments at 3-4; Boeing *Section 374 Report* Comments at 8-9; CTA *Section 374 Report* Comments at 3; CTIA *Section 374 Report* Comments at 10-13; Florida Power & Light *Section 374 Report* Comments at 1; Motorola Solutions, Inc. (Motorola Solutions) *Section 374 Report* Comments at 4 (“Provided that aeronautical mobile service is not specifically prohibited under the FCC’s rules or in the table of allocations, UAS control links should be permitted in existing mobile allocations available for both private radio and commercial operations.”); Phirst *Section 374 Report* Comments at 3-4; Small UAV Coalition *Section 374 Report* Comments at 5-6; T-Mobile *Section 374 Report* Comments at 4-6; Verizon *Section 374 Report* Comments at 2-5; Aircraft Owners and Pilots Association (AOPA) *Section 374 Report* Reply at 3 (stating that the “leveraging of cellular spectrum and infrastructure is a potential solution that the FCC should further explore”); Spectrum Financial Partners, LLC (SFP) *Section 374 Report* Reply at 3-6.

²⁵⁶ 47 CFR § 5.313. Innovation Zones are intended to provide opportunities for qualified participants to test new technologies and prototype networks – such as those that can support 5G technologies – in a specified geographic area.

²⁵⁷ “FCC Announces Two New Innovation Zones and Amends One Existing Innovation Zone for Program Experimental Licenses,” Public Notice, FCC 21-92, at 1 (Aug. 6, 2021). The North Carolina State Innovation Zones are managed by the National Science Foundation-funded Platforms for Advanced Wireless Research (PAWR) Project Office. Platforms for Advanced Wireless Research, <https://advancedwireless.org> (last visited Sept 6, 2022).

²⁵⁸ See Platforms for Advanced Wireless Research, <https://advancedwireless.org/nsf-names-third-pawr-wireless-research-platform-in-north-carolinas-research-triangle/> (Sept., 18, 2019); AERPAW: Aerial Experimentation and Research Platform for Advanced Wireless, <https://aerpaw.org/> (last visited Sept. 6, 2022).

²⁵⁹ See, e.g., CTA *Section 374 Report* Comments at 7-8; T-Mobile *Section 374 Report* Comments at 2; Verizon *Section 374 Report* Comments at 3-4, 7; CTIA *Section 374 Report* Reply at 5-6; UPS *Section 374 Report* Reply at 3-4.

²⁶⁰ See Verizon *Section 374 Report* Comments at 7.

²⁶¹ *Id.*

entered into a three-year Memorandum of Agreement to research the use of Verizon's network for command-and-control (C2) purposes and beyond-visual-line-of-sight operations.²⁶²

117. *UAS Standards.* Standards bodies, such as 3GPP,²⁶³ are conducting ongoing studies to determine the extent of interference that may be caused by UAS operations within a terrestrial network, and to develop, as necessary, techniques to manage and mitigate the increased risk of harmful interference posed by UAS.²⁶⁴ As noted, 3GPP is developing updates to its standards to enable LTE wireless networks in flexible-use bands to support UAS applications.²⁶⁵ To this end, as part of Release 15 of the technical standard for Long Term Evolution (LTE), 3GPP concluded a study item on the use of LTE for UAS, in which it proposed various interference mitigation strategies.²⁶⁶

118. The Commission's Technological Advisory Council's (TAC)²⁶⁷ Communication Strategies for Unmanned Aircraft working group was tasked with studying spectrum issues for UAS.²⁶⁸ Areas of review included the availability and sufficiency of spectrum for uses such as command-and-control, payload, identification, and collision avoidance.²⁶⁹ The working group issued a series of reports in 2019, which concluded that flexible-use mobile networks using 3GPP technologies can satisfy communications requirements for low-altitude UA, but noted that interference remains a concern and an area for further study.²⁷⁰ The ITU has also studied spectrum issues for UAS,²⁷¹ and IEEE has formed a technical committee related to aerial robotics and UAS.²⁷²

²⁶² Verizon, *Skyward and Federal Aviation Administration to test cellular-connected drones* (June 24, 2021), <https://www.verizon.com/about/news/skyward-federal-aviation-administration-test-drones>.

²⁶³ The 3rd Generation Partnership Project (3GPP) is an umbrella organization consisting of standards organizations that develop protocols for mobile telecommunications, including the Long-Term Evolution standard (LTE). *See* <https://www.3gpp.org/about-3gpp/about-3gpp> (last visited Sept. 6, 2022).

²⁶⁴ In addition, in 2017, the American National Standards Institute (ANSI) established the Unmanned Aircraft Systems Standardization Collaborative (UASSC) as a coordinating body to accelerate the development of the standards and conformity assessment programs needed to facilitate the safe integration of UAS into the U.S. national airspace. Most recently, in June 2022, ANSI released an update to its Gaps Progress Report, which tracks efforts by standards developing organizations and others to address identified gaps where additional standardization work is needed. *See* ANSI, *Gaps Progress Report Available: ANSI UASSC Standardization Roadmap for Unmanned Aircraft Systems* (June 14, 2022), <https://www.ansi.org/news/standards-news/all-news/2022/06/14-22-gaps-progress-report-available-ansi-uassc-standardization-roadmap-for-uas>.

²⁶⁵ *See supra* para. 90. *See, e.g.*, 3GPP, *UAS-UAV*, (Nov. 18, 2019), <https://www.3gpp.org/uas-uav>.

²⁶⁶ *See* 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles (Release 15) 3GPP TR 36.777 V15.0.0 (2017-12). <https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3231>

²⁶⁷ The FCC's Technological Advisory Council (TAC) provides technical advice to the FCC. The TAC is organized under the authority of the Federal Advisory Committee Act. The current TAC, which is the FCC's 5th Technological Advisory Council, was formed on October 21, 2010. The TAC is comprised of a diverse array of leading experts that helps the FCC identify important areas of innovation and develop informed technology policies supporting America's competitiveness and job creation in the global economy. <https://www.fcc.gov/general/technological-advisory-council>.

²⁶⁸ *See* Technological Advisory Council – 2019, *Documents and White Paper Releases, 2019 TAC Working Groups and Charter*, <https://www.fcc.gov/technological-advisory-council-2019>.

²⁶⁹ *See* Technological Advisory Council – 2019, *June 21, 2019 - Meeting of the Technological Advisory Council (TAC)*, (June 21, 2019), <https://www.fcc.gov/technological-advisory-council-2019>.

²⁷⁰ *See* Technology Advisory Council, *Unmanned Aircraft Systems Working Group presentations*, (Mar. 26, 2019), <https://transition.fcc.gov/oet/tac/tacdocs/meeting32619/TAC-Presentations-3-26-19.pdf>; (June 21, 2019), <https://www.fcc.gov/oet/tac/tacdocs/meeting62119/TACPpresentations6-21-19.pdf>; (Dec. 4, 2019), <https://www.fcc.gov/oet/tac/tacdocs/meeting12419/TAC-Presentations-12-4-19.pdf>.

119. As discussed above, the RTCA is working with the FAA to develop industry-endorsed standards to enable UAS. In addition to developing MOPS for line-of-sight C2 transmissions for the 5030-5091 MHz band, RTCA Special Committee 228 is currently conducting work regarding cellular network standards for UAS.²⁷³

B. Applicable Spectrum Bands

120. The flexible-use spectrum landscape for potential UAS use is varied, consisting of bands that prohibit airborne use (in the Table of Frequency Allocations or by rule) and bands that are silent on airborne operation. For example, Parts 22 and 96 explicitly prohibit the airborne use of Cellular Radiotelephone Service and CBRS spectrum.²⁷⁴ Likewise, the Table of Frequency Allocations precludes aeronautical mobile use for several other spectrum bands, including all or portions of the 1670-1675 MHz, 1.4 GHz, 2.3 GHz (Wireless Communications Service), and 3.7 GHz bands.²⁷⁵ Other flexible-use bands, however, are silent regarding airborne operations.²⁷⁶ We seek comment on the spectrum bands that might be utilized for UAS, as well as the spectrum bands that would not be suitable for such operation (e.g., frequency bands with co-channel or adjacent channel services that require protection).

121. To inform our review, commenters should indicate the flexible-use bands in which they are currently operating or testing UAS. In addition, we ask commenters to detail the flexible-use band(s) that they may be interested in using for UAS in the future, including bands with and without explicit rules or allocations prohibiting airborne use. We also ask commenters to identify the type of communication contemplated, e.g., command and control, telemetry, or payload (video, etc.) for the desired band, as well as the type of technology or infrastructure needed to support such use.

C. Sufficiency of Existing Rules

122. Certain entities maintain that our existing service and technical rules for the various flexible-use bands are sufficient to address the potential for harmful interference from UAS operations.²⁷⁷ While our existing rules promote optimal flexibility for licensees, these rules are largely focused on terrestrial operations and were not designed with airborne operations in mind. Although studies are

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²⁷¹ The ITU developed Report ITU-R M.2171 (12/2009), titled, “Characteristics of unmanned aircraft systems and spectrum requirements to support their safe operation in non-segregated airspace.” The report addresses the anticipated needs of both terrestrial and satellite spectrum requirements for UAS.

²⁷² According to the IEEE Aerial Robotics and Unmanned Aerial Vehicle Committee’s website, “The technical committee will promote exchanges among researchers from academia, industry and government. The purpose is to identify the technologies and technical approaches to advance and mature the field of aerial robotics. Exchanges include conferences, workshops, special sessions in conferences and publications to promote discussion on technical and applicative problems. Envisioned will be on-line and printed resources to disseminate knowledge including cross-disciplinary information like aerodynamics, propulsion, communications, controls and sensors.” See <https://ieee-aerialrobotics-uavs.org/>.

²⁷³ See *supra* para. 90 & n.195.

²⁷⁴ 47 CFR § 22.925 (prohibiting on airborne operation on 800 MHz Cellular Radiotelephone Service (Cellular) frequencies); 47 CFR § 96.39(h) (Citizens Broadband Radio Service Device (CBSD) general requirements).

²⁷⁵ 47 CFR § 2.106.

²⁷⁶ See, e.g., 47 CFR pt. 24, Personal Communication Services, subpt. E, Broadband PCS; 47 CFR pt. 27 Miscellaneous Wireless Communications Services, 698-746 MHz band, 1695-1710 MHz, 1710-1755 MHz, 1755-1780 MHz, 1915-1920 MHz, 1995-2000 MHz, 2000-2020 MHz, 2110-2155 MHz, 2155-2180 MHz and 2180-2200 MHz bands.

²⁷⁷ See, e.g., CTIA *Section 374 Report* Comments at 14-17; Verizon *Section 374 Report* Reply Comments at 3-4; Letter from Jackie McCarthy, Assistant Vice President, Regulatory Affairs, CTIA to Marlene H. Dortch, Secretary, FCC at 2-3 (Dec. 20, 2019).

underway to develop techniques to manage and mitigate the increased risk of harmful interference posed by UAS, at this time it is unclear whether these mitigation techniques and standards enhancements would be sufficient to protect existing wireless users and adjacent service area/band licensees from harmful interference caused by UAS use. Further, the functionality exhibited by UAs may necessitate revising our rules to enable UAS operation on existing flexible-use networks. In light of these interference concerns, we seek comment on whether modifications to our rules to protect existing terrestrial and other airborne operations are warranted.

123. *Interference mitigation.* Use of flexible-use spectrum by UAS can raise interference problems for co-channel and potentially adjacent-channel operations—particularly the high-density use that is expected to occur in the future. The impact of UAs on mobile networks is different than conventional mobile devices due to the high altitude and high mobility of UAs. The higher altitude of UAs means that they (1) can see and be seen by more base stations than a conventional mobile device; and (2) have more favorable propagation conditions than propagation experienced by terrestrial operations. In addition, this high mobility, coupled with moving velocities up to 100 miles per hour under current FAA restrictions, can result in base station handoff issues and other network issues as described in detail below.²⁷⁸ These factors underlie two scenarios in which harmful interference can occur in the presence of UAS operating on flexible-use spectrum—downlink interference and uplink interference.

124. In the downlink—communications from the base station to UAs—the UAs may operate at an altitude that is within line of sight of multiple base stations and, as a result, the UAs can receive downlink interference from those base stations. Accordingly, UAs may experience more downlink interference than terrestrial user equipment because the enhanced propagation conditions and greater line-of-sight cause downlink interference resulting from the multiple base stations visible to, and attempting to connect to, the UA. The increased downlink interference leads to increased resource utilization levels in the network and eventually degrades the downlink performance of both airborne and terrestrial equipment.²⁷⁹

125. At the same time, in the uplink—communications from the UA to the base station—the same UA can also cause interference to these multiple line-of-sight base stations. Uplink interference could increase as more UAs are introduced into the network. This interference may also increase depending on the UA's intended uses. For example, UAs may generate more uplink traffic than is typical of conventional mobile devices due to the use of data rate-intensive applications, such as video streaming and data streaming; such applications increase spectrum demand and present an increased risk of uplink interference. The increased uplink interference from UAs affects the throughput performance of terrestrial user equipment: as the number of UAs operating in a network increases, uplink resource utilization in the network also increases and at a greater rate than terrestrial-only operation. Eventually, the uplink performance of both UA and terrestrial equipment in the network is degraded.

126. To support use of UAS in terrestrial mobile networks, in 2017, 3GPP published a technical report (TR36.777) investigating the ability for UAs to be served using terrestrial LTE networks.²⁸⁰ The report's findings—which were based on the analysis of field trials performed by various

²⁷⁸ See 14 CFR § 107.51(a) (noting that the groundspeed of the small unmanned aircraft may not exceed 87 knots (100 miles per hour)).

²⁷⁹ See, e.g., Xingqin Lin et al., “The Sky is Not the Limit: LTE for Unmanned Aerial Vehicles,” *IEEE Communications Magazine*, Vol. 56, No. 4, 205 (April 2018) (The Sky is Not the Limit: LTE for Unmanned Aerial Vehicles); Siva D. Muruganathan et al., “An Overview of 3GPP Release-15 Study on Enhanced LTE Support for Connected Drones,” *IEEE Communications Standards Magazine*, Vol. 5, No. 4, 140 (December 2021).

²⁸⁰ 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles (Release 15) 3GPP TR 36.777 V15.0.0 (2017-12) (TR36.777 Report). While the TR36.777 Report uses the term “aerial user equipment” or “aerial vehicles,” for purposes of uniformity, we refer to aerial user equipment or vehicles as unmanned aircraft or UA.

companies analyzing LTE commercial network performance with the introduction of UAs—validated that downlink and uplink interference may result from UAS operation.²⁸¹ The report proposed various network and UA enhancements to minimize LTE throughput degradation and interference to the network and to UAs and terrestrial devices.²⁸²

127. TR36.777 confirmed the effect that UAS operations may have on downlink operations. The report observed that UAs uniformly distributed between 1.5 meters and 300 meters above ground level experienced downlink interference as a direct result of the UAs operating in the direct line-of-sight of more cells than terrestrial user equipment.²⁸³ This causes the UAs to receive downlink intercell interference from multiple cells.²⁸⁴ The resulting increase in resource utilization to provide for the introduction of UAs further decreases the spectral efficiency in the network and degrades downlink throughput performance of both UAs and terrestrial user equipment.²⁸⁵

128. The report similarly validated impacts on uplink interference. To this end, it also was observed that since the UAs experience line-of-sight propagation conditions to more cells than terrestrial devices, the UAs would cause interference to more cells in the uplink than a typical terrestrial device.²⁸⁶ The uplink interference caused by UAs degrades the throughput performance of terrestrial devices.²⁸⁷ The increase in resource utilization level further increases interference in the network, which in turn degrades the uplink throughput performance of both UAs and terrestrial user equipment.²⁸⁸

129. The report suggested several potential solutions to mitigate both uplink and downlink interference. Many of the solutions can be implemented by network providers independently and do not require an update to the 3GPP standard. To mitigate downlink interference, the report proposed the following solutions:

- *Full-Dimensional MIMO (FD-MIMO)* – This solution would use multiple antennas at the eNodeB (base station) transmitter to mitigate the interference in the downlink to UAs.²⁸⁹ FD-MIMO can also limit the mean terrestrial user equipment (UE) packet throughput loss.²⁹⁰
- *Directional Antenna at UAs* – Interference in the downlink can be mitigated by equipping UAs with a directional antenna instead of an omnidirectional antenna.²⁹¹ A directional antenna can be used to mitigate the interference in the downlink to UAs by decreasing the interference power coming from a broad range of angles.²⁹²
- *Receive Beamforming at UAs* – The UAs are assumed to be equipped with more than two receive antennas to mitigate the interference in the downlink to UAs.²⁹³ Downlink

²⁸¹ See generally TR36.777 Report.

²⁸² See generally TR36.777 Report.

²⁸³ TR36.777 Report at 12.

²⁸⁴ *Id.*

²⁸⁵ *Id.* at 13.

²⁸⁶ *Id.*

²⁸⁷ *Id.*

²⁸⁸ *Id.*

²⁸⁹ See TR36.777 Report at 15.

²⁹⁰ *Id.*

²⁹¹ *Id.*

²⁹² *Id.*

²⁹³ *Id.*

interference mitigation can be achieved in this case by using receive beamforming at UAs.²⁹⁴ In this solution, multiple cells belonging to the same site are coordinated and data is jointly transmitted to the UAs.²⁹⁵

- *Intra-site Joint Transmission Coordinated Multi-point Operation (JT CoMP)* – In this solution, multiple cells are coordinated and data is jointly transmitted to the UAs.²⁹⁶
- *Coverage Extension* – In this solution, coverage extension techniques via downlink shared channels, physical broadcast channels, and physical downlink shared channels are used to enhance synchronization and initial access for UAs.²⁹⁷ Because the UA is synchronized with the network, downlink interference is mitigated.²⁹⁸
- *Coordinated Data and Control Transmission* – In this solution, multiple cells belonging to the same or different sites are coordinated.²⁹⁹ Data, common signal/channels (e.g., synchronization signal and Physical Broadcast Channel (PBCH)), and control channels can be jointly transmitted to the UAs.³⁰⁰ The coordinated cells could construct a larger cell for UAs, and terrestrial user equipment is served by physical cells without coordination, simultaneously.³⁰¹ A dedicated downlink resource within the Physical Downlink Shared Channel (PDSCH) region of the coordinated cells can be reserved for these coordinated transmissions.³⁰²

²⁹⁴ *Id.*

²⁹⁵ *Id.*

²⁹⁶ The TR36.777 Report details how this solution helps to mitigate downlink interference. From the results of the UAS testing done to support the study, it was observed that when the UA UE ratio is increased from 0% to 50% and when intra-site JT CoMP is employed in the case with 50% UA UE ratio, the mean packet throughput of all user equipment can be improved by 33.4% at low offered traffic load in a UMa-AV (Urban Macro base stations mounted above buildings with UAs) scenario. TR36.777 Report at 15. When the UA UE ratio remained fixed at 50% in UMa-AV scenario, employing intra-site JT CoMP can improve the mean packet throughput for all user equipment by 58.5% at low offered traffic load compared to the case where intra-site JT CoMP is not employed. TR36.777 Report at 15.

²⁹⁷ The TR36.777 Report explains how this solution helps to mitigate downlink interference. From the results of the UAS testing done to support the study, it was observed that a noticeable fraction of the UA UE in RMa-AV (Rural Macro base stations located on top of towers with UAs) and UMa-AV (Urban Macro base stations mounted above buildings with UAs) are not in coverage for synchronization and initial access. TR36.777 Report at 16. With LTE Rel-13 coverage extension techniques, the UAs in RMa-AV and UMa-AV can achieve synchronization and initial access with 100% coverage probability. TR36.777 Report at 16.

²⁹⁸ *Id.*

²⁹⁹ According to the TR36.777 Report, this solution helps to mitigate downlink interference as it was observed that the coordinated cells could construct a larger cell for UAs, and at the same time, terrestrial user equipment are served by physical cells without coordination. TR36.777 Report at 16. For the case of high resource utilization for PDSCH (Physical Downlink Shared Channel), throughput for UAs is improved and the impact on terrestrial devices is reduced. TR36.777 Report at 16.

³⁰⁰ *Id.*

³⁰¹ *Id.*

³⁰² *Id.*

130. The report proposed the following techniques to mitigate uplink interference:

- *User Equipment Specific Fractional Pathloss Compensation Factor* – In this solution, an enhancement to the existing open loop power control mechanism is considered where a device-specific fractional pathloss compensation factor is introduced.³⁰³
- *User Equipment Specific Power Output Parameter* – Configuring a lower power output for UAs compared to terrestrial devices improves terrestrial uplink user equipment throughput performance.³⁰⁴ Such a configuration, however, reduces UA uplink throughput.³⁰⁵
- *Closed Loop Power Control* – In this solution, the target received powers for the UAs are adjusted.³⁰⁶ By applying closed loop power control, mean terrestrial user equipment uplink throughput improvement can be improved.³⁰⁷
- *Full-Dimensional MIMO (FD-MIMO)* – By using FD-MIMO with multiple antennas at the eNB receiver interference in the uplink can be mitigated.³⁰⁸ In addition, FD-MIMO can limit the mean terrestrial user equipment packet throughput loss.³⁰⁹

131. In addition to TR 36.777, 3GPP made changes to Technical Standard TS36.331 to help address UA interference to the base station. In LTE networks, measurement reports are messages sent from a UA to a base station that help the base station make network decisions.³¹⁰ The changes to TS36.331 included measurement report triggers for two reporting events: H1 (above) and H2 (below) UA height thresholds sent from the UA to the base station to help the base station see the UA and to deal with potential interference.³¹¹ 3GPP is also making additional enhancements to integrate UAS into LTE networks that do not relate to interference.³¹²

³⁰³ From the results of the UAS testing done to support the study, it was observed that with the introduction of a user equipment specific fractional pathloss compensation factor, it is possible to configure UAs with a different factor compared to the fractional pathloss compensation factor configured to the terrestrial devices. TR36.777 Report at 16-17. It was observed that with the UA ratio fixed at 50% in UMA-AV scenario, applying different fractional pathloss compensation factors for UAs and terrestrial devices can result in significant user equipment packet throughput gains for terrestrial devices and significant user equipment packet throughput losses for UAs. TR36.777 Report at 16-17. Applying height dependent fractional pathloss compensation factors for UAs can result in significant user equipment packet throughput gains for terrestrial devices and notable UE packet throughput gains for UAs. TR36.777 Report at 16-17.

³⁰⁴ TR36.777 Report at 17.

³⁰⁵ *Id.*

³⁰⁶ *Id.*

³⁰⁷ *Id.*

³⁰⁸ *Id.*

³⁰⁹ *Id.*

³¹⁰ See Haotian Deng *et al.*, Mobility Support in Cellular Networks: A Measurement Study on Its Configurations and Implications. 2018 Internet Measurement Conference (IMC '18), Boston, MA, ACM, (Oct. 31, 2018) <https://dl.acm.org/doi/10.1145/3278532.3278546>.

³¹¹ See 3GPP TS 36.331 V16.7.0 (2021-12) 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification (Release 16) (Section 5.5.4 - Measurement report triggering).

³¹² In Release 16, 3GPP completed a study into the potential requirements and use cases for Remote Identification of Unmanned Aerial Systems. See <https://www.3gpp.org/uas-uav>. The study also looked at the extent to which the 3GPP system can enable UAS components to establish the connectivity between each other and UAS Traffic Management (UTM) for both line-of-sight connectivity and non-line-of-sight connectivity, and on the detection and reporting of unauthorized UAs towards the UTM. See <https://www.3gpp.org/uas-uav>. In Release 17, 3GPP

(continued...)

132. While the 3GPP TR 36.777 report concluded that it is feasible to use existing LTE networks to provide UA connectivity, the report and its findings have their limitations. The 3GPP quantitative analyses for Release 15 evaluated only the self-network performance impact of various potential solutions to interference detection and mitigation.³¹³ Moreover, the technical solutions identified do not eliminate the interference from UAs, they merely reduce the levels of interference.³¹⁴ The report also noted that interference challenges become more visible when the density of UAs increases.³¹⁵ Beyond these limitations, the report did not evaluate the interference potential and impact on neighboring wireless networks or other radio services in the vicinity of UAS operation, nor did it evaluate the costs associated with the proposed technical solutions. As a result, there are open questions about the level of interference that licensees may experience and deem acceptable from neighboring licensees deploying UAS, the mitigation measures that may be necessary, and the costs licensees are willing to absorb to protect themselves from interference. Thus, the current 3GPP studies, while a valuable start, point to the need to address additional UAS interference issues.

133. Given that it appears that UAS operations within a single terrestrial mobile network will likely result in an increased level of intra-network interference and decreased network efficiency, it is also likely that adjacent markets and networks will be affected by UAS operations. While we seek to provide licensees with as much flexibility as possible to deploy a wide range of services and applications, including UAS, the increased risk of harmful interference from such operations is a concern. Neighboring licensees, whether they deploy or decide not to deploy UAS/airborne technologies, will be impacted and may be required to implement protections for their own networks. A difficult situation may arise for all parties when adjacent licensees—both of which are operating within the Commission’s rules—reach an impasse regarding interference, and the failure to reach a resolution may detrimentally affect operations for one or both licensees.

134. We seek comment on how licensees deploying UAS technologies could protect licensees in neighboring markets and neighboring spectrum bands from interference. Some flexible-use licensees planning to deploy airborne technology (e.g., UAS) may believe that such use is not problematic from an interference standpoint because they may assume that (1) all licensees will deploy the same technology, (2) all terrestrial networks are equally prepared to protect themselves, and (3) other potentially incompatible airborne technologies will not also be deployed. While this best-case scenario may turn out to be true as the market for airborne services develops, our rules must be expansive enough to account for the increased potential for harmful interference. Our rules should, at a minimum, set out a framework for UAS operations that is broad enough to account for varying interference scenarios. For these reasons, we seek comment on whether our rules can accommodate UAS operations while also protecting co-channel and adjacent band operations, including satellite operations, where permitted. In addition, we seek comment on changes to our rules that may be necessary to accommodate these scenarios.

135. For example, the power limitations for mobile devices vary depending on the service. For the PCS band, the limit is 2 Watts EIRP.³¹⁶ Hand-held stations operating in the 698-757 MHz, 776-

(Continued from previous page) _____
specifies additional capabilities which support UAS applications and requirements such as UA user authentication, UA tracking, and UA remote identification, among others. *See* 3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Uncrewed Aerial System (UAS) Support in 3GPP; Stage 1 (Release 17) 3GPP TS 22.125 V17.6.0 (2022-03) (Section 5 – Requirements for Remote Identification of UAS (includes tracking), and Section 7.3 - Positioning performance requirements).
<https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3545..>

³¹³ *See generally* TR36.777 Report.

³¹⁴ *See generally id.*

³¹⁵ *See id.* at 20.

³¹⁶ 47 CFR § 24.232(c).

788 MHz, 805-806 MHz, and 600 MHz uplink band are limited to 3 Watts ERP.³¹⁷ Are these and other power limitations for mobile devices in the flexible-use bands appropriate for UAS operation? Considering the increased interference potential of UAS, should the power limitations for UAs be lower than for terrestrial devices?

136. Additionally, for many services, a licensee's predicted or measured median field strength limit must be calculated and may not be exceeded at any given point along its service area boundary.³¹⁸ These limits were developed considering only terrestrial devices.³¹⁹ With the introduction of UAS, how will licensees ensure these boundary limits are not exceeded? Are the current limits³²⁰ sufficient to protect the boundary of a neighboring licensee on the same or adjacent channel block? Can a UAS report and store power control and location metrics to ensure boundary limits are not exceeded?³²¹

137. As noted, the higher the altitude at which UAs are operating, the greater the number of line of sight paths between a UA and surrounding base stations, and thus the greater the potential impact on adjacent networks. We seek comment on the altitudes that are being considered for UA operations involving flexible-use spectrum. Will operations on these bands likely be limited to low altitudes such as 400 feet AGL, or is it anticipated that UAS use on flexible-use bands will include operations at higher altitudes such as 10,000 feet AGL or greater? Given the increased potential for interference at high altitudes, should the Commission impose altitude restrictions on UAS operations using flexible-use spectrum?

138. Further, it is not clear whether existing out-of-band emissions rules adequately account for the favorable line-of-sight propagation conditions associated with UAS. Should such rules be modified to account for UAS operations in flexible-use spectrum, and if so, how? We seek comment on these and other technical rules that should be evaluated and perhaps revised to facilitate the use of flexible-use bands for UAS.

139. To inform our analysis regarding whether rule revisions may be necessary, we seek technical studies and analyses regarding the potential for UAS operations to cause interference to adjacent channel, adjacent band, or adjacent market operations. Among other issues, these studies and analyses should address how licensees deploying UAS technologies plan to protect terrestrial or satellite licensees in neighboring markets or spectrum bands from harmful interference. We request comment on the challenges and issues that carriers have experienced when testing or deploying UAS operations relative to the carrier's own terrestrial wireless network. What solutions have carriers developed or are carriers developing to address those challenges, specifically, the hardware, software, processes required, as well as the costs entailed in deploying such solutions? What UAS altitude and UA density assumptions have been used to analyze deployment challenges and protection of neighbors? Are these solutions to be implemented applicable to the UA, or are they network-based? For licensees employing LTE, can the solutions identified in the 3GPP TR36.777 Report be applied to resolve interference issues within the network and to adjacent networks? Given that flexible-use spectrum licensees may deploy networks other than LTE, what additional interference issues may be encountered and what are the technical solutions that could be applied, given that there may be varying levels of compatibility with airborne technologies?

³¹⁷ 47 CFR § 27.50(b)(10), (c)(10).

³¹⁸ See, e.g., 47 CFR §§ 24.236, 27.55(a).

³¹⁹ In general, the geographic area licensees' service area power limits in sections 22.913(b) and 27.55(d) and (e) of the Commission's rules that are measured at a height 1.6 meters above ground level to estimate the height of a mobile (UE) taking into account terrain obstacles. See 47 CFR §§ 22.913(b), 27.55(d), (e).

³²⁰ See 47 CFR §§ 24.236, 27.55(a).

³²¹ See 3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Study on Enhanced LTE Support for Aerial Vehicles (Release 15) 3GPP TR 36.777 V15.0.0 (2017-12). Section 7.1 Potential enhancements for interference detection.

We note that some areas, such as Quiet Zones require the application of more stringent measures to reduce the potential for interference;³²² how will licensees continue to protect such areas when operating at higher altitudes?³²³ Are there network-based solutions being developed that could prevent individual UAs from approaching or entering such noise-sensitive locations or other restricted areas that would mitigate the potential for UAs to cause interference or endanger safety of life and property in such areas? We also seek comment on any other regulatory matters that may be affected by UAS operations. For example, will UAS/airborne technologies affect other regulatory requirements like 911 location accuracy?

140. *Different Use Cases.* Our regulatory approach with respect to flexible-use bands is to provide licensees with sufficient flexibility to choose the services that they wish to provide. Licensees could offer a wide range of services and applications, ranging from “conventional” C2 and payload offerings to UTM management services. This ability of licensees to engage in a wide range of use cases creates additional technical uncertainty when deploying UAS operations. We seek comment on the airborne use cases that commenters are considering for flexible-use spectrum. Is there a need for specific rules to permit different applications? Further, should licensees that incorporate UAS operations be required to meet different limitations than what currently exist?

141. One application being explored is the use of UAs as airborne base stations.³²⁴ HAPS systems can potentially be used to provide both fixed broadband connectivity for end users and transmission links between the mobile and core networks for backhauling traffic. As noted, the Commission’s rules—as well as ITU Radio Regulations—define HAPS as radio stations located on an object at an altitude of 12-31 miles (20-50 kilometers) and at a specified, nominal, fixed point relative to the Earth.³²⁵

142. We note that the Commission is currently considering whether HAPS or other stratospheric-based services could be used in any portion of the 71-76 GHz, 81-86 GHz, 92-94 GHz, and 94.1-95 GHz (70/80/90 GHz) bands to provide or support broadband Internet access.³²⁶ Are there flexible-use bands that could potentially accommodate such use?³²⁷ Would such use be compatible with “conventional” UAS and terrestrial, flexible-use operations given the potential impact that such high altitude use could have on other operations in the band? If so, what rule changes or regulatory considerations would be necessary to permit such uses?

³²² Section 1.924 of the Commission’s rules identifies areas in which it is necessary to restrict transmissions to minimize impact on radio astronomy or other facilities that are highly sensitive to interference. 47 CFR § 1.924; *see also supra* para. 105.

³²³ *See, e.g.*, 47 CFR § 27.1134 (Protection of Federal Government operations).

³²⁴ *See, e.g.*, Steve McCaskill, *Aerial base station delivers 4G coverage from the Earth's stratosphere* (Oct. 20, 2020), <https://www.techradar.com/news/aerial-base-station-delivers-4g-coverage-from-the-earths-stratosphere>; Miriam McNabb, *Aero Vironment to Develop High Altitude Solar Drones* (Jan. 3, 2018), <https://dronelife.com/2018/01/03/aerovironment-develop-high-altitude-solar-drones>.

³²⁵ 47 CFR § 2.1; *accord* ITU R.R., Article 1.66A (2020); *see supra* para. 98.

³²⁶ *See* “Wireless Telecommunications Bureau Seeks To Supplement the Record on 70/80/90 GHz Bands Notice Of Proposed Rulemaking,” Public Notice, DA 21-1263 (WTB Oct. 8, 2021). This public notice was issued to supplement the record in the rulemaking on *Modernizing and Expanding Access to the 70/80/90 GHz Bands*. *Modernizing and Expanding Access to the 70/80/90 GHz Bands*, WT Docket No. 20-133, Notice of Proposed Rulemaking, 35 FCC Rcd 6039 (2020) (seeking comment on, among other things, potential rule changes for non-Federal users to facilitate the provision of wireless backhaul for 5G, as well as the deployment of broadband services to aircraft and ships).

³²⁷ We observe that the Commission has previously granted experimental authorizations for high-altitude testing using flexible-use spectrum. *See, e.g.*, Physical Science Laboratory/New Mexico State University, Special Temporary Authorization, OET Experimental Licensing System File No.: 0020-EX-CM-2022; Loon, LLC, Special Temporary Authorization, OET Experimental Licensing System File No.: 0609-EX-CN-2020.

143. Other examples of airborne base station platforms include the use of tethered UAS, which typically are UAs physically connected to the ground via cables that provide power and data links to the UAs.³²⁸ We are aware that there has been research and development in the use of tethered UAS as temporary base stations, particularly as part of disaster recovery efforts.³²⁹ What issues are raised by the use of tethered UAS temporary base stations? If the station is essentially functioning as a conventional base station, should the existing rules applicable to the particular band be applied? Or is it necessary to apply other service and technical parameters, e.g., antenna height and power output? What additional concerns are raised where tethered UAS base stations as well as HAPS are deployed? Further, what would be the impact of a mobile airborne base station on airborne user equipment (i.e., UAS)? What changes or additions to our rules are necessary to address such concerns?

144. *Elimination of Rules Which Impede UAS.* In its Final Report, the BVLOS ARC recommended that the Commission reconsider the restrictions on airborne use that apply to certain spectrum bands.³³⁰ The *BVLOS ARC Final Report* noted that beyond-visual-line-of-sight operations require that spectrum bands with appropriate characteristics are sufficiently available to meet the needs of numerous users operating in a variety of operating environments.³³¹ Similarly, the TAC has noted that the Commission should reassess the technical basis for prohibiting use of certain terrestrial mobile bands above ground level.³³² To the extent that measures can be identified that resolve or mitigate the impact of UAS use on adjacent operations, we seek comment on whether current prohibitions on airborne operations should be removed. For example, the Cellular Radiotelephone Service airborne use prohibition in section 22.925 was put in place specifically because of the heightened risk of interference by airborne mobiles to cellular networks. Can such operations be protected in the presence of UAS use? If solutions are developed that effectively mitigate the increased potential for harmful interference posed by UAS use, should UAS operations be permitted in Cellular Radiotelephone Service or other bands? Are there certain noise-restricted bands that must retain the prohibition regardless of any UAS interference mitigation measures?³³³ If a commenter seeks to eliminate or modify an existing prohibition, the commenter should specifically explain why the airborne use would not cause harmful interference to a co-channel or adjacent channel licensee's operations.

145. *Canadian and Mexican Coordination.* The use of UAS will likely have an impact in areas beyond United States borders. There are several agreements that address use of the flexible-use

³²⁸ See Mustafa A. Kishk et al., *On the 3-D Placement of Airborne Base Stations Using Tethered UAVs*, IEEE Transactions on Communications (Aug. 2020), <https://ieeexplore-ieee.org.fcc.idm.oclc.org/stamp/stamp.jsp?tp=&arnumber=9091128>.

³²⁹ See, e.g., *Take a look at AT&T's 'Flying COWs' — drones that returned cell service to Hurricane Ida-hit Louisiana*, Business Insider (Sept. 4, 2021), <https://www.businessinsider.com/flying-cows-bring-cell-service-to-areas-impacted-natural-disasters-2021-8>; *COM Sovereign Delivers First Tethered Drone-Based LTE Network* (Dec. 21, 2020), <https://www.prnewswire.com/news-releases/comsovereign-delivers-first-tethered-drone-based-lte-network-301196568.html>; Monica Allevan, "T-Mobile applies for extension to test UAS in Washington," FierceWireless (Feb. 12, 2019), <https://www.fiercewireless.com/wireless/t-mobile-applies-for-extension-to-test-uas-bellevue-redmond>.

³³⁰ *BVLOS ARC Final Report* at 61.

³³¹ *Id.*

³³² Technical Advisory Council, Unmanned Aircraft Systems Working Group March 26, 2019 Presentation at 25-35, <https://transition.fcc.gov/oet/tac/tacdocs/meeting32619/TAC-Presentations-3-26-19.pdf>.

³³³ There are restrictions on aeronautical or airborne mobile use in or adjacent to noise-restricted bands. For example, in the 1670-1675 MHz band, aeronautical mobile is prohibited to protect radio astronomy operations. See 47 CFR § 2.106, footnotes US211, US342.

bands in the border regions between the United States, Canada, and Mexico.³³⁴ These agreements do not contemplate UAS use. Because UAS operation in these bands would increase the interference potential in the border regions, commenters should be aware that UAS use may not be permitted in border areas until such time as the agreements are updated to accommodate such use, or agreements on such use are reached with both countries. We seek comment on how to address issues arising from UAS use in the border regions pending any changes to existing agreements.

D. UAS Impact on Spectrum Rights

146. The Commission's rules largely presume that wireless networks are terrestrial in nature, which raises questions regarding the extent of spectrum rights granted as part of existing commercial authorizations. Pursuant to the Communications Act and the Commission's rules, the Commission grants licensees the right to operate radio systems on a particular radio frequency.³³⁵ In some services, such as those with allocations prohibiting aeronautical mobile use, it can be presumed that a licensee only has rights with respect to ground-based operations.³³⁶ Likewise, other services have technical rules which suggest that only terrestrial networks were contemplated for those services.³³⁷ By contrast, rules for geographic market-based licenses define market areas according to geographic boundaries, but they are silent as to the vertical scope of such markets.³³⁸ The Commission has never explicitly stated what it believes to be the vertical limit of a licensee's spectrum rights, leaving a question as to the "ceiling" of license areas and the attendant protections associated with these geographic markets. As the interference discussion above highlights, however, market boundaries become crucial at higher altitudes.

147. The ability of a licensee to exercise or protect its spectrum rights with respect to adjacent licensees becomes relevant in the context of UAS use, given that the operation of UAs well within the boundaries of one license area can affect and be affected by base stations located inside the boundaries of another license area—more so than for conventional mobile operation. UAs will have line-of-sight connectivity to base stations both within the geographic market area where the UA is flying, as well as base stations in other adjacent geographic areas. The potential for a UA to establish a network connection with a base station in an adjacent market causes a tension between Commission policies: (1) a licensee's authorization generally provides the licensee exclusive use of the spectrum within its licensed market area; and (2) historically, our rules consider mobile devices to be operating under the authority of the licensee whose transmitter is providing service. UA operation creates a tension between these two

³³⁴ See, e.g., Canada Agreements By Frequency, <https://www.fcc.gov/canadian-agreements-frequency>, (700 MHz Commercial Land Mobile Agreement with Canada, Understanding Concerning Cellular Radio Systems in the bands 824-825 MHz, 845-849 MHz, 869-870 MHz, and 890-894 MHz, Personal Communications Service (PCS)-Broadband); Mexico Agreements By Frequency, <https://www.fcc.gov/mexican-agreements-frequency>, (Cellular (Protocol 4), Personal Communication Service (PCS)-Broadband 8).

³³⁵ 47 U.S.C. § 303; 47 CFR § 1.903.

³³⁶ Several allocations in the Table of Frequency Allocations, including 1670-1675 MHz, 2305-2310 MHz, 2495-2690 MHz and 3550-3700 MHz bands, permit primary non-Federal mobile, except aeronautical mobile, operations. 47 CFR § 2.106.

³³⁷ For example, PCS service rules specify maximum antenna height and output power of base stations. 47 CFR § 24.232. In the Cellular Radiotelephone Service, license areas are determined by a licensee's Cellular Service Area Boundary (SAB), which is the area around a base station transmitter within which a subscriber can receive a specific signal level. See 47 CFR § 22.911. The license area defined by this service contour is, in essence, a dome around the transmitter. *Id.*

³³⁸ See, e.g., 47 CFR §§ 24.202, 27.6. A geographic market licensee generally may construct a transmitter tower anywhere within a particular geographic area's boundary (subject to certain interference protection and other technical requirements) and does not need to apply for prior Commission approval of specific transmitter locations. See, e.g., 47 CFR § 27.11(a) ("Applications for individual sites are not required and will not be accepted, except where required for environmental assessments, in accordance with §§ 1.1301 through 1.1319 of this chapter."); 47 CFR § 90.663.

policies because a UA can be served by a transmitter that is well outside of the licensee's market boundary.³³⁹ The greater line-of-sight of UAs could extend the reach of a transmitter further into an adjacent market, thus muddling the concept of license exclusivity.

148. This aspect of UAS use raises questions regarding how and under what circumstances a licensee is able to enforce rights under its license.³⁴⁰ For example, it may be difficult to determine UAS operation as a cause of interference to a network because such operation is intermittent and because the effect may vary depending on the position and movement of the UA. Moreover, even if UAS operation is determined to be a cause of interference, the offending licensee is likely to be operating within the Commission's rules regarding conventional mobile operations. This poses questions regarding the circumstances under which the "victim" licensee, i.e., the licensee experiencing harmful interference, may seek relief from the Commission where both entities are compliant with service rules.

149. Accordingly, we seek comment on whether the Commission should identify a vertical limit at which flexible-use licenses may be used to support UAS on an exclusive or primary basis. Use beyond this limit would be on a non-primary basis. "Non-primary" in this context would mean that a licensee would be required to cure harmful interference to an adjacent licensee caused by its UAS operation even if it is operating within the rules.³⁴¹ First, is it appropriate to establish a vertical limit for primary UAS operations in our rules? If we adopt a limit, what should that limit be? What factors should the Commission consider regarding a vertical limit for licensed UAS operations?

150. Second, we seek comment on how to determine whether a licensee should be required to cure harmful interference caused by its non-primary operations to adjacent licensees even if it is operating within the service rules for the license. How should we determine whether an entity should be obligated to take corrective measures, as there may be scenarios in which it could be difficult to determine fault? We request comment on how licensees should be able to enforce their license rights. What interference resolution mechanism would be appropriate?

IV. LICENSING UAS OPERATORS FOR VHF COMMUNICATIONS

151. The aeronautical VHF band (117.975 MHz -137 MHz) is used by aviation for air traffic control and advisory communications among other aviation-safety purposes.³⁴² In some instances, to ensure the safety of the National Airspace System, the FAA requires operators of UAS to communicate with air traffic control (ATC) facilities when operating on or in the vicinity of an airport or operating in controlled airspace over the VHF traffic control and advisory frequencies.³⁴³ To meet this requirement,

³³⁹ In the current mobile environment this happens to a limited extent at a market boundary. Currently, base stations situated along a market boundary can serve a conventional mobile located close to the boundary in the adjacent market; this is beneficial to both licensees as it permits continued service and seamless handoff across boundaries. UA, however, could be served by base stations well within the adjacent market boundary due to a greater line-of-sight.

³⁴⁰ See Technological Advisory Committee, UAS Working Group March 26, 2019 Presentation, <https://transition.fcc.gov/oet/tac/tacdocs/meeting32619/TAC-Presentations-3-26-19.pdf> (last visited June 14, 2022).

³⁴¹ "Non-primary" status would not mean that a licensee would not have interference protection for its own operation. The non-primary status would only convey responsibility for curing interference even if that licensee is operating within rules.

³⁴² See 47 CFR § 87.173(b); *Review of Part 87 of the Commission's Rules Concerning the Aviation Radio Service*, WT Docket No. 01-289, Third Report and Order, 25 FCC Rcd 7610, 7612, para. 3 (2010).

³⁴³ See 14 CFR §§ 91.126 Operating on or in the vicinity of an airport in Class G airspace, 91.183 IFR communications; *see also, e.g.*, Supplemental Statement of BNSF Railway Co., FCC File No. 0008476737, at 1 (filed Dec. 20, 2018), *available at* (last visited June 14, 2022) (stating that "[t]he ability for BNSF to have a active participation on the proposed aviation channels is of major importance to the FAA" and that "the FAA has requested BNSF obtain an aircraft stations license from the FCC" that will be "used to communicate directly to ATC"); *see also* FAA Order JO 7210.3CC – Facility Operation and Administration, at 5-5-3(b),

(continued...)

operators may use a VHF station integrated into the UA itself whereby the UAS operator's control station connects with the UA using a non-VHF channel and the UA completes the connection to ATC over the normal VHF channels. This approach is commonly referred to as ATC relay.³⁴⁴ Implementation of ATC relay in UA technology is still nascent and UAS operators have, therefore, continued to rely on ground-based VHF stations. The part 87 aviation service rules governing the use of the aeronautical VHF band do not, however, provide a licensing mechanism for the operator of a UAS to obtain a ground-based station license.³⁴⁵ Accordingly, UAS operator requests for such authorization are currently handled by special temporary authority on a case-by-case basis. We propose to establish a mechanism by which UAS operators may apply for a regular license for this purpose, with appropriate requirements, restrictions, and conditions to maintain the integrity of the band and service legitimate needs for flight coordination.

152. Although aeronautical VHF stations are generally licensed by rule under part 87 if the aircraft does not make international flights or communications,³⁴⁶ we do not propose to authorize ground-based VHF stations under a licensed-by-rule approach. Rather, under our proposal, we would require operators to file a license application with the Commission for an individual license covering their VHF station. According to the FAA, there were over 200,000 private aircraft registered in the United States as of 2020 and were over 7,000 commercial aircraft as of 2019, numbers which are expected to remain relatively stable to the year 2040.³⁴⁷ In contrast, the recreational UAS fleet is expected to grow from the current 1.32 million units to approximately 1.48 million units by 2024.³⁴⁸ The FAA also forecasts that, by the year 2024, the commercial UAS fleet will likely be twice as large as the current fleet of approximately 385,000 UAS.³⁴⁹ Given the potential number of UAS operators, we have concerns that a licensed-by-rule approach applied to these operators' stations in the VHF band could endanger this critical and limited amount of aeronautical spectrum and the safety of the National Airspace System.

153. In addition, given the wide availability of inexpensive, off-the-shelf VHF hand-held radios that can be easily operated without training, we are concerned about the greater potential for parties to obtain and use ground stations on a licensed-by-rule basis to contact ATC, because they may not have adequate training for such communications. We are further concerned that licensed-by-rule operators would be difficult to identify during communications with ATC or afterwards in the event of problems.

(Continued from previous page) _____
https://www.faa.gov/air_traffic/publications/atpubs/foa_html/chap5_section_5.html (last visited June 14, 2022) (providing that the "Operations Supervisor/Controller-in-Charge (OS/CIC) should ensure . . . if known, that the controller has a method of contacting the appropriate UAS [pilot-in-command]").

³⁴⁴ For example, the technical standard RTCA DO-362A would potentially provide for the use of CNPC links in the 5030-5091 MHz band to support the link between operator and UA for purposes of ATC relay. *See* RTCA DO-362A, § 1.1. and B.3.1.2.

³⁴⁵ This issue does not arise for pilots aboard manned aircraft, who use stations for VHF communications under subpart F of part 87 of the Commission's rules. *See* 47 CFR pt. 87, subpt. F. Subpart F authorizes aircraft stations, which, as mentioned earlier, are defined as stations "located on board an aircraft." 47 CFR §§ 87.5, 87.185(a). Because ground stations are not "located on board an aircraft," they are not covered by subpart F.

³⁴⁶ *See* 47 CFR § 87.18(b).

³⁴⁷ *See* FAA, *FAA Aerospace Forecast: Fiscal Years 2020-2040* at 26, 32, https://www.faa.gov/data_research/aviation/aerospace_forecasts/media/FY2020-40_FAA_Aerospace_Forecast.pdf (last visited June 14, 2022) (*FAA Aerospace Forecast*). While the private aircraft fleet is expected to slightly decrease, the number of flight hours is expected to increase. *Id.* at 26, 27. The commercial fleet is expected to grow by approximately 1% per year. *Id.* at 32.

³⁴⁸ *Id.* at 49.

³⁴⁹ *Id.* at 52.

We tentatively conclude that ground stations for VHF communications should not be licensed by rule, and seek comment on our analysis and tentative conclusion.³⁵⁰

154. While we typically do not individually license aircraft stations operating on VHF for domestic flights and communications, we seek comment on licensing ATC relay operations. As discussed above, ATC relay implementation is currently in its nascent stage, however we expect relay operations to increase with a corresponding increase in UA operations near airports and in controlled airspace. Given that ATC relay and ground-based VHF stations will both be used to communicate with ATC, are there inherent differences between ground radio operators and relay operators for the purpose of the communications? Is there a reason to expect operators using ATC relay stations are better trained for such communications? Are there other licensing related issues that we should consider that make relay systems unique?

155. We seek to adopt a licensing mechanism that addresses these concerns and maintains the integrity of the band while also meeting the legitimate needs of certain UAS operators for communications in the VHF band. To achieve these goals, we propose several measures below. We seek comment on these measures, and on any alternative approaches that would provide a regular licensing mechanism that meets the Commission's goals.

156. First, we propose to individually license ground stations for UAS operator communication with control towers and other aircraft pilots under a new category of licensed station, an *Unmanned Aircraft Operator VHF Ground Station*, and to define the new station as “a station on the ground providing unmanned aircraft pilot radio communication relating to safety and regularity of flight on air traffic control, flight service station, unicom, or multicom frequencies.”³⁵¹ Individual licensing will enable the Commission to identify authorized operators, identify unauthorized users, and aid in resolving instances of harmful interference. Accordingly, under this proposal, parties will be required to submit individual license applications. We propose that parties use the FCC Form 605, which is used generally for, *inter alia*, authorizations for stations in the “aircraft service,” and we seek comment on whether any modifications to the form are necessary or helpful to facilitate its use for this purpose.³⁵²

157. Second, we propose to provide that these stations may operate over all air traffic control, flight service station, aeronautical advisory station (unicom), and aeronautical multicom station (multicom) channels authorized for use by aircraft.³⁵³ We seek comment on which specific channels to cover for this purpose.³⁵⁴

158. Third, we propose to permit mobile stations (stations intended to be used while in motion or during halts at unspecified points), and we further seek comment on whether to permit non-mobile stations as well. To the extent parties support the inclusion of non-mobile stations, we seek comment on

³⁵⁰ We also note that section 307(e) of the Act expressly limits licensing by rule in the aviation service to aircraft stations and, as discussed, we seek to adopt a licensing mechanism for VHF ground stations. *See* 47 U.S.C. § 307(e).

³⁵¹ A flight service station is part of a network of stations providing weather briefings and information on flight facilities and monitoring the navigational radio net. *See Review of Part 87 of the Commission's Rules Concerning the Aviation Radio Service*, WT Docket No. 01-289, Report and Order and Further Notice of Proposed Rule Making, 18 FCC Rcd 21432, 21459, para. 56, n.209 (2003). A unicom station is an aeronautical station used for advisory and civil defense communications primarily with private aircraft. 47 CFR § 87.5. A multicom station is an aeronautical station used to provide communications to conduct the activities being performed by, or directed from, private aircraft. *Id.*

³⁵² FCC Form 605 provides a quick-form application for authorization for, among others, stations in the “aircraft service” generally. *See* FCC Form 605, <https://www.fcc.gov/fcc-form-605>.

³⁵³ *See* 47 CFR § 87.173(b); *see also* 47 CFR subpts. G, H.

³⁵⁴ *See* 47 CFR §§ 87.173(b), 87.187(a), 87.187(y)(2) (flight service station frequencies).

whether coverage of such stations for communications between two non-mobile sites (i.e., the operator's fixed VHF station and air traffic control) is consistent with the aeronautical mobile and aeronautical mobile (route) allocations applicable to the air traffic control frequencies.³⁵⁵

159. Fourth, we propose to require that license applications include an endorsement from the FAA. An endorsement must be included in a written document issued by the FAA, such as a Certificate of Approval (COA). We propose to provide that a license will not be issued without an FAA endorsement. We further propose that the approved license will be subject to any restrictions or conditions specified on the FAA endorsement. While licenses under part 87 are normally issued for 10 years, we seek comment on whether to provide that license terms for these stations will be the lesser of 10 years or the duration of the FAA endorsement, if any is specified. We further seek comment on whether a party seeking license renewal should be required to submit a new FAA written endorsement.

160. Finally, we propose to adopt a clarification of section 87.18 that will make clear that licensing by rule continues to apply to UAS aircraft stations, such as the VHF stations used for ATC relay. As discussed above, while we seek comment on whether the concerns that underlie our proposal that a UAS operator's ground-based VHF stations should be individually licensed warrant the same approach for UAS aircraft stations, we are not proposing at this time to require individual licensing for those UAS aircraft stations used for VHF communications. To avoid any confusion as to the continued application of licensing by rule to such stations that might result from our proposal to license a UAS operator's ground-based VHF station individually, we propose to clarify in section 87.18(b) that licensing by rule applies to aircraft stations, whether "manned or unmanned."

161. We believe these steps will help to promote the safe integration of UAS into the National Airspace System, while maintaining the integrity of the aeronautical VHF band. We request comment on these proposals and alternatives. We seek comment on whether a provision enabling UAS operators to license ground-based stations to communicate over the aeronautical VHF band is necessary or if instead we should continue to address requests for authorization for ground-based stations on a case-by-case basis. If providing a mechanism for licensing of ground-based VHF stations is warranted, we seek comment on whether the proposed rules adequately address this need or unduly restrict the ability of UAS operators to communicate with ATC or with manned aircraft. Conversely, we seek comment on whether the proposal is too broad, and whether we should further restrict the circumstances under which UAS operators may obtain licensed ground stations to use the aeronautical VHF band. We also request comment on whether the FAA's planned integration of the Next Gen Data Communications system into the 136-137 MHz band or other innovations have any current or future effect on this need, including whether they may alter the frequencies that a future UAS operator needs to use to communicate with ATC or otherwise warrant modifications to our proposal.³⁵⁶

162. We further seek comment on the appropriate technical and operational requirements for the new category of station, and whether we should generally require such stations to comply with the technical and operational requirements applicable to aircraft stations licensed in the same frequency, or if any additional or alternate requirements should be adopted. In particular, we note that, under section 87.89 of the Commission's rules, operators of aviation service stations are generally required to hold a commercial radio operator license or permit, and that the operator license or permit requires passing a requisite knowledge test.³⁵⁷ The rule also specifies, however, that no operator license is required to

³⁵⁵ See 47 CFR § 2.106. For example, the aeronautical mobile service allocation covers "mobile service between aeronautical [i.e., ground] stations and aircraft stations, or between aircraft stations," and does not expressly encompass service between two fixed stations. 47 CFR § 2.1.

³⁵⁶ See, e.g., *Aviation NPRM*, 34 FCC Rcd at 4995-96, paras. 31-32.

³⁵⁷ See 47 CFR § 87.89; FCC, *Commercial Radio Operator License Program*, <https://www.fcc.gov/commercial-radio-operator-license-program> (last visited July 15, 2022).

“[o]perate a VHF telephony transmitter providing domestic service or used on domestic flights.”³⁵⁸ We seek comment on whether a UAS operator’s VHF communications with ATC would constitute the operation of a VHF telephony transmitter providing domestic service or used on domestic flights, and if so, whether we should create an exception to this provision and provide that UAS operators that operate a licensed Unmanned Aircraft Operator Ground VHF Station must have a commercial radio operator license. Should we specify an alternative permit or training requirement for such operators?

163. *Digital Equity and Inclusion.* Finally, the Commission, as part of its continuing effort to advance digital equity for all,³⁵⁹ including people of color, persons with disabilities, persons who live in rural or Tribal areas, and others who are or have been historically underserved, marginalized, or adversely affected by persistent poverty or inequality, invites comment on any equity-related considerations³⁶⁰ and benefits (if any) that may be associated with the proposals and issues discussed herein. Specifically, we seek comment on how our proposals in this NPRM may promote or inhibit advances in diversity, equity, inclusion, and accessibility, as well the scope of the Commission’s relevant legal authority.

V. PROCEDURAL MATTERS

164. *Ex Parte Presentations.* This proceeding shall be treated as a “permit-but-disclose” proceeding in accordance with the Commission’s *ex parte* rules.³⁶¹ Persons making *ex parte* presentations must file a copy of any written presentation or a memorandum summarizing any oral presentation within two business days after the presentation (unless a different deadline applicable to the Sunshine period applies). Persons making oral *ex parte* presentations are reminded that memoranda summarizing the presentation must: (1) list all persons attending or otherwise participating in the meeting at which the *ex parte* presentation was made, and (2) summarize all data presented and arguments made during the presentation. If the presentation consisted in whole or in part of the presentation of data or arguments already reflected in the presenter’s written comments, memoranda or other filings in the proceeding, the presenter may provide citations to such data or arguments in his or her prior comments, memoranda, or other filings (specifying the relevant page and/or paragraph numbers where such data or arguments can be found) in lieu of summarizing them in the memorandum. Documents shown or given to Commission staff during *ex parte* meetings are deemed to be written *ex parte* presentations and must be filed consistent with rule 1.1206(b). In proceedings governed by rule 1.49(f) or for which the Commission has made available a method of electronic filing, written *ex parte* presentations and memoranda summarizing oral *ex parte* presentations, and all attachments thereto, must be filed through the electronic comment filing system available for that proceeding, and must be filed in their native format (e.g., .doc, .xml, .ppt, searchable .pdf). Participants in this proceeding should familiarize themselves with the Commission’s *ex parte* rules.

³⁵⁸ 47 CFR § 87.89(d)(4).

³⁵⁹ Section 1 of the Communications Act of 1934, as amended, provides that the FCC “regulat[es] interstate and foreign commerce in communication by wire and radio so as to make [such service] available, so far as possible, to all the people of the United States, without discrimination on the basis of race, color, religion, national origin, or sex.” 47 U.S.C. § 151.

³⁶⁰ The term “equity” is used here consistent with Executive Order 13985 as the consistent and systematic fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of color; members of religious minorities; lesbian, gay, bisexual, transgender, and queer (LGBTQ+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality. *See* Exec. Order No. 13985, 86 Fed. Reg. 7009, Executive Order on Advancing Racial Equity and Support for Underserved Communities Through the Federal Government (Jan. 20, 2021).

³⁶¹ 47 CFR § 1.1200 *et seq.*

165. *Comment Period and Filing Procedures.* Pursuant to sections 1.415 and 1.419 of the Commission's rules, 47 CFR §§ 1.415, 1.419, interested parties may file comments and reply comments on or before the dates indicated on the first page of this document. Parties may file by any of the following methods:

- Electronic Filers: Comments may be filed electronically using the Internet by accessing the Commission's Electronic Comment Filing System (ECFS): <https://www.fcc.gov/ecfs/>. See *Electronic Filing of Documents in Rulemaking Proceedings*, 63 FR 24121 (1998).
- Paper Filers: Parties who choose to file by paper must file an original and one copy of each filing.
 - Filings can be sent by commercial overnight courier, or by first-class or overnight U.S. Postal Service mail. All filings must be addressed to the Commission's Secretary, Office of the Secretary, Federal Communications Commission.
 - Commercial overnight mail (other than U.S. Postal Service Express Mail and Priority Mail) must be sent to 9050 Junction Drive, Annapolis Junction, MD 20701.
 - U.S. Postal Service first-class, Express, and Priority mail must be addressed to 45 L Street NE Washington, DC 20554.
 - Effective March 19, 2020, and until further notice, the Commission no longer accepts any hand or messenger delivered filings. This is a temporary measure taken to help protect the health and safety of individuals, and to mitigate the transmission of COVID-19. See *FCC Announces Closure of FCC Headquarters Open Window and Change in Hand-Delivery Policy*, Public Notice, 35 FCC Red 2788, 2788-89 (OS 2020), <https://www.fcc.gov/document/fcc-closes-headquarters-open-window-and-changes-hand-delivery-policy>.

166. *People with Disabilities.* To request materials in accessible formats for people with disabilities (braille, large print, electronic files, audio format), send an e-mail to fcc504@fcc.gov or call the Consumer & Governmental Affairs Bureau at 202-418-0530 (voice), 202-418-0432 (TTY).

167. *Regulatory Flexibility Act.* The Regulatory Flexibility Act of 1980, as amended (RFA),³⁶² requires that an agency prepare a regulatory flexibility analysis for notice and comment rulemakings, unless the agency certifies that "the rule will not, if promulgated, have a significant economic impact on a substantial number of small entities."³⁶³ Accordingly, the Commission has prepared an Initial Regulatory Flexibility Analysis (IRFA) concerning the possible impact the rule and policy changes addressed in this *NPRM*. The IRFA is set forth in Appendix B.

168. *Paperwork Reduction Act Analysis.* This document contains proposed new or modified information collection requirements. The Commission, as part of its continuing effort to reduce paperwork burdens, invites the general public and the Office of Management and Budget (OMB) to comment on the information collection requirements contained in this document, as required by the Paperwork Reduction Act of 1995, Public Law 104-13. In addition, pursuant to the Small Business Paperwork Relief Act of 2002, Public Law 107-198, see 44 U.S.C. § 3506(c)(4), we seek specific comment on how we might further reduce the information collection burden for small business concerns with fewer than 25 employees.

169. *Additional Information.* For additional information on this proceeding, contact Peter Trachtenberg, Mobility Division, Wireless Telecommunications Bureau, at 202-418-7369, or by email at Peter.Trachtenberg@fcc.gov.

³⁶² 5 U.S.C. § 603.

³⁶³ *Id.* § 605(b).

VI. ORDERING CLAUSES

170. Accordingly, IT IS ORDERED, pursuant to Sections 1, 4, 301, 303, 307-310, 316, 318, and 332 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 154, 301, 303, 307-310, 316, 318, and 332, that this Notice of Proposed Rulemaking IS HEREBY ADOPTED.

171. IT IS FURTHER ORDERED that the Petition for Rulemaking filed by the Aerospace Industries Association in the Commission's rulemaking proceeding RM-11798 IS GRANTED to the extent specified herein, that RM-11798 is incorporated into this proceeding, WT Docket No. 22-XX, and that RM-11798 is TERMINATED.

172. IT IS FURTHER ORDERED that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, SHALL SEND a copy of this Notice of Proposed Rulemaking, including the Initial Regulatory Flexibility Analysis, to the Chief Counsel for Advocacy of the Small Business Administration.

FEDERAL COMMUNICATIONS COMMISSION

Marlene H. Dortch
Secretary

APPENDIX A**Proposed Rules**

The Federal Communications Commission proposes to amend Parts 1 and 87 of Title 47 of the Code of Federal Regulations (CFR) and to add a new Part 88 to Title 47 of the CFR, as follows:

PART 1 – WIRELESS RADIO SERVICES

1. The authority citation for Part 1 continues to read as follows:

AUTHORITY: 47 U.S.C. chs. 2, 5, 9, 13; 28 U.S.C. 2461 note, unless otherwise noted.

2. Section 1.901 is revised to read as follows:

§ 1.901 Basis and Purpose

The rules in this subpart are issued pursuant to the Communications Act of 1934, as amended, 47 U.S.C. 151 et seq. The purpose of the rules in this subpart is to establish the requirements and conditions under which entities may be licensed in the Wireless Radio Services as described in this part and in parts 13, 20, 22, 24, 27, 30, 74, 80, 87, 88, 90, 95, 96, 97, and 101 of this chapter.

3. Section 1.907 is amended to revise the definitions of “Private Wireless Services” and “Wireless Radio Services” to read as follows:

§ 1.907 Wireless Radio Services

Private Wireless Services. Wireless Radio Services authorized by parts 80, 87, 88, 90, 95, 96, 97, and 101 that are not Wireless Telecommunications Services, as defined in this part.

Wireless Radio Services. All radio services authorized in parts 13, 20, 22, 24, 26, 27, 30, 74, 80, 87, 88, 90, 95, 96, 97 and 101 of this chapter, whether commercial or private in nature.

PART 87 – AVIATION SERVICES

4. The authority citation for Part 87 continues to read as follows:

AUTHORITY: 47 U.S.C. 154, 303 and 307(e), unless otherwise noted.

5. Section 87.3 is amended by adding subsection (g) to read as follows:

§ 87.3 Other applicable rule parts.

* * * * *

(g) Part 88 contains rules governing the use of the 5030-5091 MHz band by Unmanned Aircraft Systems.

6. Section 87.5 is amended by adding in alphabetical sequence a definition of “unmanned aircraft operator VHF ground station” to read as follows:

§ 87.5 Definitions.

* * * * *

Unmanned Aircraft Operator VHF Ground Station. A station on the ground providing unmanned aircraft pilot radio communication relating to safety and regularity of flight on air traffic control, flight service station, unicom, or multicom frequencies.

* * * * *

7. Section 87.18 is amended by adding the words “(manned or unmanned)” after “An aircraft station” in the first sentence of paragraph (b), and by adding paragraph (c) to read as follows:

§ 87.18 Station license required.

* * * * *

(c) Notwithstanding paragraph (a) of this section, unmanned aircraft operator VHF ground stations are not licensed by rule and must be licensed by the FCC either individually or by fleet for communications on air traffic control, flight service station, unicom, or multicom frequencies in accordance with § 87.49 of this part.

8. Section 87.49 is added to read as follows:

§ 87.49 Application for an Unmanned Aircraft Operator VHF Station license.

A person may apply for an Unmanned Aircraft Operator VHF Ground Station license to communicate on air traffic control, flight service station, unicom, or multicom frequencies if written approval is first obtained from the FAA. The applicant must provide, with the license application, a copy of the written approval from the FAA, such as a Certificate of Waiver or Authorization (COA), approving the applicant’s use of the specific frequencies requested in connection with unmanned aircraft activity. License grant will be subject to any conditions, coordination, or restrictions imposed by the FAA in its written approval.

9. A new part 88 is added to read as follows:

PART 88 –UNMANNED AIRCRAFT CONTROL SERVICES

AUTHORITY: 47 U.S.C. 154(i), 303, 307.

Subpart A – GENERAL RULES

§ 88.1 Scope.

§ 88.3 Application of Other Rule Parts.

§ 88.5 Definitions.

Subpart B – NON-NETWORKED ACCESS

§ 88.25 Scope.

§ 88.27 Authorization.

§ 88.29 Frequencies.

§ 88.31 Non-Networked Access Use.

Subpart C – (reserved)

Subpart D – TECHNICAL REQUIREMENTS

§ 88.101 Transmitter power.

§ 88.103 Bandwidth of emission.

§ 88.105 Types of emission.

§ 88.107 Acceptability of transmitters for licensing.

§ 88.109 Authorization of equipment.

§ 88.111 Performance standards.

§ 88.113 RF Safety.

§ 88.115 Incorporation by Reference.

Subpart E – DYNAMIC FREQUENCY MANAGEMENT SYSTEMS

§ 88.135 DFMS Requirements.

§ 88.137 DFMS Administrators.

§ 88.139 DFMS Administrator Fees.

Subpart A – GENERAL RULES

§ 88.1 Scope.

This part sets forth the regulations governing the use of the 5030-5091 MHz band by Unmanned Aircraft Systems. The regulations in this part do not govern Unmanned Aircraft Systems communications services in any bands other than the 5030-5091 MHz band.

§ 88.3 Application of Other Rule Parts.

- (a) Except as expressly provided under this part, part 87 of this chapter shall not apply to unmanned aircraft systems communications in the 5030-5091 MHz band.
- (b) Non-Networked Access (NNA) devices, as defined in this part, are considered part of the Citizens Band Radio Service, as defined in § 95.303 of this chapter. Except for § 95.303, the rules of part 95 of this chapter shall not apply to such devices.

§ 88.5 Definitions.

The following terms and definitions apply only to the rules in this part.

Ground Station: A land or mobile station not on board an unmanned aircraft (UA) that is part of an unmanned aircraft system (UAS) and for communication with an unmanned aircraft station.

Control and Non-payload Communications (CNPC). Any UAS transmission that is sent to or from the UA component of the UAS and that supports the safety or regularity of the UA's flight.

Dynamic Frequency Management System (DFMS). An automated frequency coordination system operating in the 5030-5091 MHz band that, in response to frequency assignment requests from UAS operators, assigns to the requesting operator, through an automated (non-manual) process, temporary use of certain frequencies for a particular geographic area and time period tailored to the operator's submitted flight plan.

DFMS Administrator. An entity authorized by the Commission to operate a DFMS in accordance with the rules and procedures set forth in subpart E of this part.

Non-Networked Access (NNA). Temporary, interference-protected access to the 5030-5091 MHz band pursuant to a frequency assignment from a DFMS and consistent with subpart B of this part.

NNA device. A ground station or unmanned aircraft station authorized under this part and designed to communicate using NNA assignments consistent with subparts B and D.

NNA user. An authorized user of spectrum in the 5030-5091 MHz band operating on an NNA basis, as set forth in subpart B.

Unmanned Aircraft (UA). An aircraft operated without the possibility of direct human intervention from within or on the aircraft.

Unmanned Aircraft Station. A mobile station authorized under this part and located on board a UA.

Unmanned Aircraft System (UAS). A UA and its associated elements (including an unmanned aircraft station, communication links, and the components not on board the UA that control the UA) that are required for the safe and efficient operation of the UA in the airspace of the United States.

Subpart B – NON-NETWORKED ACCESS

§ 88.25 Scope.

Transmissions over an NNA assignment may include any form of CNPC.

§ 88.27 Authorization.

- (a) Any entity, other than those precluded by section 310 of the Communications Act of 1934, as amended, 47 U.S.C. 310, and otherwise meets the technical, financial, character, and citizenship qualifications that the Commission may require in accordance with such Act is eligible to be an NNA user and operate NNA devices under this part.
- (b) NNA devices, including Ground Stations and Unmanned Aircraft Stations, are licensed by rule and do not need an individual license issued by the Commission. Even though an individual license is not required, an NNA device licensed by rule must comply with all applicable operating requirements, procedures, and technical requirements found in this part.
- (c) NNA users must register with a DFMS and comply with its instructions and the rules in this part.
- (d) NNA users may transmit in the 5030-5091 MHz band only using NNA devices compliant with the rules of this part, and only pursuant to and consistent with the terms of a frequency assignment from a Commission-approved DFMS.

§ 88.29 Frequencies.

The 5030-5035 MHz and 5086-5091 MHz bands are allocated for CNPC use to NNA users.

§ 88.31 Non-Networked Access Use.

- (a) NNA users registered with a DFMS may submit a request for temporary assignment of frequencies for CNPC limited to the duration and geographic coverage necessary to support a single submitted UAS flight plan. Requests may also be made either prior to or during the relevant operation to modify an assignment. Such requests must be made to the same DFMS responsible for the original assignment.
- (b) If frequencies meeting the request are available, the DFMS shall assign them on an exclusive but temporary basis. The scope of the assignment shall be tailored in both duration and geographic coverage to ensure interference-free communications for the entire submitted UAS flight plan.
- (c) When registering with or using the services of a DFMS, an NNA user shall comply with all instructions of the DFMS Administrator, including those regarding registration, requests and other submissions to the DFMS, and operational use of NNA assignments.
- (d) An NNA user operating under a DFMS assignment must provide indication to the DFMS, within 5 minutes of the event, when a flight has commenced and when it has terminated.
- (e) NNA users are prohibited from engaging in UAS operations using NNA assignments within the National Radio Quiet Zone (NRQZ) without prior coordination with the NRQZ administrator. Any request to a DFMS for frequency assignment within the NRQZ must include submission of a Letter of Concurrence from the NRQZ administrator, and NNA users submitting such a request shall comply with all conditions enumerated in the Letter of Concurrence. NNA users are urged to take all practicable steps to protect radio astronomy observations in the 5000-5250 MHz band.

Subpart C – [Reserved]**Subpart D – TECHNICAL REQUIREMENTS****§ 88.101 Transmitter power.**

The power of the transmitter is defined as the average envelope measured during the duration of the burst transmission bounded by the first preamble symbol to the last midamble symbol, measured at the transmitter's RF output port with a 50 ohm load attached. The power must be determined by direct measurement at the transmitter output terminals. The maximum power of a transmitter must not exceed the values listed below.

- (a) Airborne Radio Transmitter:
 - (i) High Power Mode: 10 watts
 - (ii) Low Power Mode: 100 mW
- (b) Ground Radio Transmitter: 10 watts

§ 88.103 Bandwidth of emission.

The authorized bandwidth is the maximum occupied bandwidth authorized to be used by a station. Equipment must be tunable in 2.5 kHz steps within the range 5030-5091 excluding center frequencies 5030 MHz and 5091 MHz. The authorized bandwidth is limited to multiples of 5 kHz according to the following:

- (a) One In-flight Emergency Video Channel having a width of 500 kHz.

(b) Two takeoff and Landing Video Channels of 250 kHz width per channel.

(c) Non-Video Channels may operate on up to 250 kHz-wide channels in multiples of 5 kHz.

§ 88.105 Types of emission.

The assignable Emission Designators in multiples of 5 kHz up to 500 kHz are as follows:

G8D – for data

G8F – for video

§ 88.107 Acceptability of transmitters for licensing.

Each transmitter utilized for operation under this part and each transmitter marketed as set forth in § 2.803 of this chapter must be certificated by the Commission following the procedures set forth in part 2, subpart J of this chapter.

§ 88.109 Authorization of equipment.

An applicant for certification of equipment must notify the FAA of the filing of a certification application. The letter of notification must be mailed to: FAA, Office of Spectrum Policy and Management, ASR-1, 800 Independence Ave., SW, Washington, DC 20591 prior to the filing of the application with the Commission.

(a) The notification letter must describe the equipment, and give the manufacturer's identification, antenna characteristics, rated output power, emission type and characteristics, the frequency or frequencies of operation, and essential receiver characteristics if protection is required.

(b) The certification application must include a copy of the notification letter to the FAA. The Commission will not act until it receives the FAA's determination regarding whether it objects to the application for equipment authorization. The FAA should mail its determination to: Office of Engineering and Technology Laboratory, Authorization and Evaluation Division, 7435 Oakland Mills Rd., Columbia, MD 21046. The Commission will consider the FAA determination before taking final action on the application.

§ 88.111 Performance standards.

Transmitters operating in the 5030-5091 MHz band must comply with and operate in accordance with technical standard *RTCA-DO-362A* (incorporated by reference, see § 88.115).

§ 88.113 RF Safety.

Licensees and manufacturers are subject to the radio frequency radiation exposure requirements specified in §§ 1.1307(b), 1.1310, 2.1091, and 2.1093 of this chapter, as appropriate. Applications for equipment authorization of Mobile devices operating under this section must contain a statement confirming compliance with these requirements for both fundamental emissions and unwanted emissions and technical information showing the basis for this statement must be submitted to the Commission upon request.

§ 88.115 Incorporation by Reference.

The standards listed in this section are incorporated by reference into this part with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. The approved

material is available for inspection at the Federal Communications Commission (FCC), 45 L Street NE, Reference Information Center, Room 1.150, Washington, DC 20554, (202) 418-0270, and is available from the sources indicated below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, email fedreg.legal@nara.gov or go to www.archives.gov/federal-register/cfr/ibr-locations.html. Copies of RTCA standards also may be obtained from RTCA, 1150 18th Street NW, Suite 910, Washington, DC 20036, or by email to info@rtca.org or by going to <http://RTCA.org>.

- (a) RTCA document titled “Command and Control (C2) Data Link Minimum Operational Performance Standards (MOPS) (Terrestrial),” Document No. RTCA-DO-362A, dated December 17, 2020 (*RTCA-DO-362A*).
- (b) Reserved.

Subpart E – DYNAMIC FREQUENCY MANAGEMENT SYSTEMS

§ 88.135 DFMS Requirements.

- (a) DFMS must provide a process for NNA users to register with the system for the purpose of submitting frequency assignment requests, obtaining frequency assignments.
- (b) A DFMS must be capable of processing frequency assignment requests nationwide and across the entire 5030-5091 MHz band. However, a DFMS may only grant assignments for spectrum within those frequencies specified under § 88.29.
- (c) In response to frequency assignment requests from a registered NNA user, a DFMS shall determine and provide, through an automated (non-manual) process, an assignment of frequencies for a particular geographic area and time period tailored to the NNA user’s submitted flight plan, to the extent that frequencies are available to meet the request and grant of the assignment is otherwise consistent with this rule part. Assignments must provide protected access to frequencies over a duration and geographic area sufficient to cover the entire submitted flight plan.
- (d) Assignments for operations in the National Radio Quiet Zone (NRQZ) must be accompanied by a Letter of Concurrence from the NRQZ Administrator and may only be granted within the terms and conditions, if any, specified in the Letter of Concurrence.
- (e) Assignments must account for the need to protect other authorized operations.

§ 88.137 DFMS Administrators.

The Commission will approve one or more DFMS Administrators to manage access to the 5030-5091 MHz band on a nationwide basis as specified under § 88.135. Each DFMS Administrator is responsible for the functioning of a DFMS and providing services to operators in the Unmanned Aircraft Control Service. Each DFMS Administrator approved by the Commission must:

- (a) Operate a DFMS consistent with the rules of this part.
- (b) Establish and follow protocols and procedures to ensure compliance with the rules set forth in this part.
- (c) Provide service for a ten-year term. This term may be renewed at the Commission's discretion.

- (d) Securely transfer all the information in the DFMS to another approved entity in the event it does not continue as the DFMS Administrator at the end of its term. It may charge a reasonable price for such conveyance.
- (e) Cooperate to develop a standardized process for coordinating operations with other approved DFMSs, avoiding any conflicting assignments, and maximizing shared use of available frequencies.
- (f) Coordinate with other DFMS Administrators including, to the extent possible, sharing assignment and other information, facilitating non-interference to and from operations relying on assignments from other DFMSs, and other functions necessary to ensure that use of available spectrum is safe and efficient and consistent with this part.
- (g) Ensure that the DFMS shall be available at all times to immediately respond to requests from authorized Commission personnel for any and all information stored or retained by the DFMS.
- (h) Establish and follow protocols to comply with enforcement instructions from the Commission.

§ 88.139 DFMS Administrator Fees.

- (a) A DFMS Administrator may charge users a reasonable fee for provision of its services, including usage-based fees for frequency assignments.
- (b) The Commission, upon request, will review the fees and can require changes in those fees if they are found to be excessive.

APPENDIX B

Initial Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (RFA),¹ the Commission has prepared this present Initial Regulatory Flexibility Analysis (IRFA) of the possible significant economic impact on a substantial number of small entities by the policies and rules proposed in the *Notice of Proposed Rulemaking (NPRM)*. Written public comments are requested on this IRFA. Comments must be identified as responses to the IRFA and must be filed by the deadlines for comments provided in the *NPRM*. The Commission will send a copy of the *NPRM*, including this IRFA, to the Chief Counsel for Advocacy of the Small Business Administration (SBA).² In addition, the *NPRM* and IRFA (or summaries thereof) will be published in the Federal Register.³

A. Need for, and Objectives of, the Proposed Rules

2. The *NPRM* in this proceeding acts, in part, on a February, 2018 petition for rulemaking by the Aerospace Industries Association (AIA), which recommended that the Commission adopt licensing and service rules for control and non-payload communications (CNPC) links in the 5030-5091 MHz band to support unmanned aircraft system (UAS) operations in the United States. In addition, on August 20, 2021, the Wireless Telecommunications Bureau and Office of Engineering and Technology jointly submitted to Congress a report on behalf of the Commission addressing the matters specified in Section 374 of the FAA Reauthorization Act of 2018 (FAA Reauthorization Act). The report included their finding that “[t]he 5030-5091 MHz band appears to offer promise for intensive UAS use because it is unencumbered” and recommended that the Commission initiate a rulemaking proceeding to develop service and licensing rules enabling UAS use of the band in collaboration with the FAA and NTIA.

3. The *NPRM* now proposes and seeks comment on several rule amendments to address the growing need of the operators of UAS for access to licensed spectrum. Together, the proposals and the measures upon which the *NPRM* seeks comment will help further the development and promote the growth and safety of UAS operations.

4. First, the *NPRM* addresses the 5030-5091 MHz band, which the Commission previously allocated to support terrestrial control links for UAS without adopting service rules. Because technical work regarding UAS is still in a nascent stage, the Commission anticipates that service rules sufficient to facilitate UAS operations will likely require development in phases. It now takes the first step to develop such rules. The *NPRM* seeks comment on service rules for the 5030-5091 MHz band that will provide UAS operators with access to licensed spectrum with the reliability necessary to support safety-critical UAS communications links. The Commission’s objective in this proceeding is to provide UAS operators with access to an additional spectrum resource that may complement other spectrum resources that are currently available or in development. Although existing networks operating in other bands such as flexible-use bands may provide sufficient reliability for many UAS use cases, authorization of the 5030-5091 MHz band for UAS use offers an opportunity to apply standards and rules designed to meet the most safety-critical communications needs.

5. Second, due to the increasing interest in operating UAS using existing terrestrial flexible-use spectrum networks, the *NPRM* seeks comment on whether the Commission’s rules are adequate to ensure co-existence of terrestrial mobile operations and UAS use or whether changes to our rules are necessary. To this end, it seeks comment on the sufficiency of the current flexible-use rules to prevent

¹ See 5 U.S.C. § 603. The RFA, 5 U.S.C. §§ 601-612, has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), Pub. L. No. 104-121, Title II, 110 Stat. 857 (1996).

² See 5 U.S.C. § 603(a).

³ See *id.*

interference to and from UAS operations, and on whether the Commission can eliminate the current prohibitions on airborne operations applicable to certain of these flexible-use bands.

6. Third, to further promote the safe integration of unmanned aircraft operations in controlled airspace and facilitate flight coordination, the *NPRM* proposes a process for UAS operators to obtain a VHF license to communicate with air traffic control and other aircraft. In some instances, to ensure the safety of the National Airspace System, the FAA has required operators of UAS to communicate with air traffic control facilities or nearby manned aircraft over the VHF traffic control and advisory frequencies and to obtain a license from the FCC for this purpose. The part 87 aviation service rules do not, however, provide a mechanism for the operator of a UAS to obtain such a license. UAS operator requests for such authorization are currently handled by special temporary authority on a case-by-case basis. The proposed rule will enable UAS operators to obtain a regular license for this purpose.

B. Legal Basis

7. The proposed action is authorized pursuant to Sections 1, 4, 301, 303, 307-310, 316, 318, and 332 of the Communications Act of 1934, as amended, 47 U.S.C. §§ 151, 154, 301, 303, 307-310, 316, 318, and 332.

C. Description and Estimate of the Number of Small Entities to Which the Proposed Rules Will Apply

8. The RFA directs agencies to provide a description of and, where feasible, an estimate of the number of small entities that may be affected by the proposed rules, if adopted.⁴ The RFA generally defines the term “small entity” as having the same meaning as the terms “small business,” “small organization,” and “small governmental jurisdiction.”⁵ In addition, the term “small business” has the same meaning as the term “small-business concern” under the Small Business Act.⁶ A “small-business concern” is one which: (1) is independently owned and operated; (2) is not dominant in its field of operation; and (3) satisfies any additional criteria established by the SBA.⁷

9. *Small Businesses, Small Organizations, Small Governmental Jurisdictions.* Our actions, over time, may affect small entities that are not easily categorized at present. We therefore describe here, at the outset, three broad groups of small entities that could be directly affected herein.⁸ First, while there are industry specific size standards for small businesses that are used in the regulatory flexibility analysis, according to data from the Small Business Administration’s (SBA) Office of Advocacy, in general a small business is an independent business having fewer than 500 employees.⁹ These types of small businesses represent 99.9% of all businesses in the United States, which translates to 32.5 million businesses.¹⁰

⁴ See *id.* § 603(b)(3).

⁵ See *id.* § 601(6).

⁶ See *id.* § 601(3) (incorporating by reference the definition of “small-business concern” in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies “unless an agency, after consultation with the Office of Advocacy of the Small Business Administration and after opportunity for public comment, establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register.”

⁷ See 15 U.S.C. § 632.

⁸ See 5 U.S.C. § 601(3)-(6).

⁹ See SBA, Office of Advocacy, Frequently Asked Questions, “What is a small business?,” <https://cdn.advocacy.sba.gov/wp-content/uploads/2021/11/03093005/Small-Business-FAQ-2021.pdf>. (Nov 2021).

¹⁰ *Id.*

10. Next, the type of small entity described as a “small organization” is generally “any not-for-profit enterprise which is independently owned and operated and is not dominant in its field.”¹¹ The Internal Revenue Service (IRS) uses a revenue benchmark of \$50,000 or less to delineate its annual electronic filing requirements for small exempt organizations.¹² Nationwide, for tax year 2020, there were approximately 447,689 small exempt organizations in the United States reporting revenues of \$50,000 or less according to the registration and tax data for exempt organizations available from the IRS.¹³

11. Finally, the small entity described as a “small governmental jurisdiction” is defined generally as “governments of cities, counties, towns, townships, villages, school districts, or special districts, with a population of less than fifty thousand.”¹⁴ U.S. Census Bureau data from the 2017 Census of Governments¹⁵ indicate that there were 90,075 local governmental jurisdictions consisting of general purpose governments and special purpose governments in the United States.¹⁶ Of this number there were 36,931 general purpose governments (county,¹⁷ municipal, and town or township¹⁸) with populations of less than 50,000 and 12,040 special purpose governments - independent school districts¹⁹ with enrollment

¹¹ 5 U.S.C. § 601(4).

¹² The IRS benchmark is similar to the population of less than 50,000 benchmark in 5 U.S.C § 601(5) that is used to define a small governmental jurisdiction. Therefore, the IRS benchmark has been used to estimate the number of small organizations in this small entity description. See Annual Electronic Filing Requirement for Small Exempt Organizations — Form 990-N (e-Postcard), <https://www.irs.gov/charities-non-profits/annual-electronic-filing-requirement-for-small-exempt-organizations-form-990-n-e-postcard>. We note that the IRS data does not provide information on whether a small exempt organization is independently owned and operated or dominant in its field.

¹³ See Exempt Organizations Business Master File Extract (EO BMF), “CSV Files by Region,” <https://www.irs.gov/charities-non-profits/exempt-organizations-business-master-file-extract-eo-bmf>. The IRS Exempt Organization Business Master File (EO BMF) Extract provides information on all registered tax-exempt/non-profit organizations. The data utilized for purposes of this description was extracted from the IRS EO BMF data for businesses for the tax year 2020 with revenue less than or equal to \$50,000, for Region 1-Northeast Area (58,577), Region 2-Mid-Atlantic and Great Lakes Areas (175,272), and Region 3-Gulf Coast and Pacific Coast Areas (213,840) which includes the continental U.S., Alaska, and Hawaii. This data does not include information for Puerto Rico.

¹⁴ 5 U.S.C. § 601(5).

¹⁵ See 13 U.S.C. § 161. The Census of Governments survey is conducted every five years, compiling data for years ending with “2” and “7.” See also Census of Governments, <https://www.census.gov/programs-surveys/cog/about.html>.

¹⁶ See U.S. Census Bureau, 2017 Census of Governments – Organization Table 2: Local Governments by Type and State: 2017 [CG1700ORG02], <https://www.census.gov/data/tables/2017/econ/gus/2017-governments.html>. Local governmental jurisdictions are made up of general purpose governments (county, municipal, and town or township) and special purpose governments (special districts and independent school districts). See also Table 2. CG1700ORG02 Table Notes Local Governments by Type and State_2017.

¹⁷ See *id.* at tbl.5. County Governments by Population-Size Group and State: 2017 [CG1700ORG05], <https://www.census.gov/data/tables/2017/econ/gus/2017-governments.html>. There were 2,105 county governments with populations less than 50,000. This category does not include subcounty (municipal and township) governments.

¹⁸ See *id.* at tbl.6. Subcounty General-Purpose Governments by Population-Size Group and State: 2017 [CG1700ORG06], <https://www.census.gov/data/tables/2017/econ/gus/2017-governments.html>. There were 18,729 municipal and 16,097 town and township governments with populations less than 50,000.

¹⁹ See *id.* at tbl.10. Elementary and Secondary School Systems by Enrollment-Size Group and State: 2017 [CG1700ORG10], <https://www.census.gov/data/tables/2017/econ/gus/2017-governments.html>. There were 12,040 independent school districts with enrollment populations less than 50,000. See also Table 4. Special-Purpose Local Governments by State Census Years 1942 to 2017 [CG1700ORG04], CG1700ORG04 Table Notes Special Purpose Local Governments by State Census Years 1942 to 2017.

populations of less than 50,000.²⁰ Accordingly, based on the 2017 U.S. Census of Governments data, we estimate that at least 48,971 entities fall into the category of “small governmental jurisdictions.”²¹

12. *Wireless Telecommunications Carriers (except Satellite)*. This industry comprises establishments engaged in operating and maintaining switching and transmission facilities to provide communications via the airwaves.²² Establishments in this industry have spectrum licenses and provide services using that spectrum, such as cellular services, paging services, wireless internet access, and wireless video services.²³ The SBA size standard for this industry classifies a business as small if it has 1,500 or fewer employees.²⁴ U.S. Census Bureau data for 2017 show that there were 2,893 firms in this industry that operated for the entire year.²⁵ Of that number, 2,837 firms employed fewer than 250 employees.²⁶ Additionally, based on Commission data in the 2021 Universal Service Monitoring Report, as of December 31, 2020, there were 797 providers that reported they were engaged in the provision of wireless services.²⁷ Of these providers, the Commission estimates that 715 providers have 1,500 or fewer employees.²⁸ Consequently, using the SBA’s small business size standard, most of these providers can be considered small entities.

13. *Satellite Telecommunications*. This industry comprises firms “primarily engaged in providing telecommunications services to other establishments in the telecommunications and broadcasting industries by forwarding and receiving communications signals via a system of satellites or reselling satellite telecommunications.”²⁹ Satellite telecommunications service providers include satellite and earth station operators. The SBA small business size standard for this industry classifies a business with \$35 million or less in annual receipts as small.³⁰ U.S. Census Bureau data for 2017 show that 275 firms in this industry operated for the entire year.³¹ Of this number, 242 firms had revenue of less than

²⁰ While the special purpose governments category also includes local special district governments, the 2017 Census of Governments data does not provide data aggregated based on population size for the special purpose governments category. Therefore, only data from independent school districts is included in the special purpose governments category.

²¹ This total is derived from the sum of the number of general purpose governments (county, municipal, and town or township) with populations of less than 50,000 (36,931) and the number of special purpose governments - independent school districts with enrollment populations of less than 50,000 (12,040), from the 2017 Census of Governments - Organizations tbls. 5, 6, and 10.

²² See U.S. Census Bureau, *2017 NAICS Definition, “517312 Wireless Telecommunications Carriers (except Satellite),”* <https://www.census.gov/naics/?input=517312&year=2017&details=517312>.

²³ *Id.*

²⁴ See 13 CFR § 121.201, NAICS Code 517312.

²⁵ See U.S. Census Bureau, *2017 Economic Census of the United States, Employment Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEEMPFI, NAICS Code 517312, <https://data.census.gov/cedsci/table?v=2017&n=517312&tid=ECNSIZE2017.EC1700SIZEEMPFI&hidePreview=false>.

²⁶ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard.

²⁷ Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2021), <https://docs.fcc.gov/pub/ld/attachments/DOC-379181A1.pdf>.

²⁸ *Id.*

²⁹ See U.S. Census Bureau, *2017 NAICS Definition, “517410 Satellite Telecommunications,”* <https://www.census.gov/naics/?input=517410&year=2017&details=517410>.

³⁰ See 13 CFR § 121.201, NAICS Code 517410.

³¹ See U.S. Census Bureau, *2017 Economic Census of the United States, Selected Sectors: Sales, Value of Shipments, or Revenue Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEREFI, NAICS Code 517410,

(continued...)

\$25 million.³² Additionally, based on Commission data in the 2021 Universal Service Monitoring Report, as of December 31, 2020, there were 71 providers that reported they were engaged in the provision of satellite telecommunications services.³³ Of these providers, the Commission estimates that approximately 48 providers have 1,500 or fewer employees.³⁴ Consequently using the SBA's small business size standard, a little more than of these providers can be considered small entities.

14. *All Other Telecommunications.* This industry is comprised of establishments primarily engaged in providing specialized telecommunications services, such as satellite tracking, communications telemetry, and radar station operation.³⁵ This industry also includes establishments primarily engaged in providing satellite terminal stations and associated facilities connected with one or more terrestrial systems and capable of transmitting telecommunications to, and receiving telecommunications from, satellite systems.³⁶ Providers of Internet services (e.g. dial-up ISPs) or voice over Internet protocol (VoIP) services, via client-supplied telecommunications connections are also included in this industry.³⁷ The SBA small business size standard for this industry classifies firms with annual receipts of \$35 million or less as small.³⁸ U.S. Census Bureau data for 2017 show that there were 1,079 firms in this industry that operated for the entire year.³⁹ Of those firms, 1,039 had revenue of less than \$25 million.⁴⁰ Based on this data, the Commission estimates that the majority of "All Other Telecommunications" firms can be considered small.

15. *Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing.* This industry comprises establishments primarily engaged in manufacturing radio and television broadcast and wireless communications equipment.⁴¹ Examples of products made by these establishments are: transmitting and receiving antennas, cable television equipment, GPS equipment, pagers, cellular phones, mobile communications equipment, and radio and television studio and

(Continued from previous page)

<https://data.census.gov/cedsci/table?v=2017&n=517410&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false>.

³² *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, see https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

³³ Federal-State Joint Board on Universal Service, Universal Service Monitoring Report at 26, Table 1.12 (2021), <https://docs.fcc.gov/pub/ld/lic/attachments/DOC-379181A1.pdf>.

³⁴ *Id.*

³⁵ See U.S. Census Bureau, 2017 NAICS Definition, "517919 All Other Telecommunications," <https://www.census.gov/naics/?input=517919&year=2017&details=517919>.

³⁶ *Id.*

³⁷ *Id.*

³⁸ See 13 CFR § 121.201, NAICS Code 517919.

³⁹ See U.S. Census Bureau, 2017 Economic Census of the United States, Selected Sectors: Sales, Value of Shipments, or Revenue Size of Firms for the U.S.: 2017, Table ID: EC1700SIZEREVFIRM, NAICS Code 517919, <https://data.census.gov/cedsci/table?v=2017&n=517919&tid=ECNSIZE2017.EC1700SIZEREVFIRM&hidePreview=false>.

⁴⁰ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard. We also note that according to the U.S. Census Bureau glossary, the terms receipts and revenues are used interchangeably, see https://www.census.gov/glossary/#term_ReceiptsRevenueServices.

⁴¹ See U.S. Census Bureau, 2017 NAICS Definition, "334220 Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing," <https://www.census.gov/naics/?input=334220&year=2017&details=334220>.

broadcasting equipment.⁴² The SBA small business size standard for this industry classifies businesses having 1,250 employees or less as small.⁴³ U.S. Census Bureau data for 2017 show that there were 656 firms in this industry that operated for the entire year.⁴⁴ Of this number, 624 firms had fewer than 250 employees.⁴⁵ Thus, under the SBA size standard, the majority of firms in this industry can be considered small.

16. *Unmanned Aircraft Radio Equipment Manufacturers.* Neither the Commission nor the SBA have developed a small business size standard specifically applicable to unmanned aircraft radio equipment manufacturers. Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing is the closest industry with a SBA small business size standard.⁴⁶ The SBA small business size standard for this industry classifies businesses having 1,250 employees or less as small.⁴⁷ U.S. Census Bureau data for 2017 show that there were 656 firms in this industry that operated for the entire year.⁴⁸ Of this number, 624 firms had fewer than 250 employees.⁴⁹ In addition, the SBA provides a size standard for the Aircraft Manufacturing industry which includes the manufacture of unmanned and robotic aircraft.⁵⁰ The SBA small business size standard for this industry classifies businesses having 1,500 employees or less as small.⁵¹ U.S. Census Bureau data for 2017 show that there were 254 firms in this industry that operated for the entire year.⁵² Of this number, 227 firms had fewer than 250 employees.⁵³ Based on these data, we conclude that a majority of manufacturers in this industry are small.

⁴² *Id.*

⁴³ See 13 CFR § 121.201, NAICS Code 334220.

⁴⁴ See U.S. Census Bureau, *2017 Economic Census of the United States, Employment Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEEMPFIEM, NAICS Code 334220, <https://data.census.gov/cedsci/table?y=2017&n=334220&tid=ECNSIZE2017.EC1700SIZEEMPFIEM&hidePreview=false>.

⁴⁵ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard.

⁴⁶ See U.S. Census Bureau, *2017 NAICS Definition, "334220 Radio and Television Broadcasting and Wireless Communications Equipment Manufacturing,"* <https://www.census.gov/naics/?input=334220&year=2017&details=334220>.

⁴⁷ See 13 CFR § 121.201, NAICS Code 334220.

⁴⁸ See U.S. Census Bureau, *2017 Economic Census of the United States, Employment Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEEMPFIEM, NAICS Code 334220, <https://data.census.gov/cedsci/table?y=2017&n=334220&tid=ECNSIZE2017.EC1700SIZEEMPFIEM&hidePreview=false>.

⁴⁹ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard.

⁵⁰ See U.S. Census Bureau, *2022 NAICS Definition, "336411 Aircraft Manufacturing,"* <https://www.census.gov/naics/?input=336411&year=2022&details=336411>.

⁵¹ See 13 CFR § 121.201, NAICS Code 336411.

⁵² See U.S. Census Bureau, *2017 Economic Census of the United States, Employment Size of Firms for the U.S.: 2017*, Table ID: EC1700SIZEEMPFIEM, NAICS Code 336411, <https://data.census.gov/cedsci/table?y=2017&n=336411&tid=ECNSIZE2017.EC1700SIZEEMPFIEM&hidePreview=false>.

⁵³ *Id.* The available U.S. Census Bureau data does not provide a more precise estimate of the number of firms that meet the SBA size standard.

17. *Unmanned Aircraft System Operators.* Neither the Commission nor the SBA have developed a small business size standard specifically applicable to UAS operators. The Commission lacks data on the number of operators in the United States that could be subject to the rules therefore, it is not possible to determine the number of affected small entity operators at this time. We find, however, that the Regulatory Flexibility Analysis of the Federal Aviation Administration (FAA) Remote ID rule is helpful. In this analysis, the FAA assessed the impact of the rule on small entity non-recreational UAS operators based on an analysis that the Association for Unmanned Vehicle Systems International (AUVSI) performed relating to part 107 waivers.⁵⁴ In the analysis, the AUVSI determined that 92 percent of the waivers were issued to entities with fewer than 100 employees. Based on this data, the FAA determined that a majority of entities operating unmanned aircraft for other than recreational purposes are small.⁵⁵ Accordingly, based on the FAA's determination, we conclude that a majority of UAS operators are small entities.

D. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements

18. The *NPRM* proposes to adopt a band plan and service rules for the 5030-5091 MHz band to enable small and other UAS operators, to access interference-protected spectrum for control-and-non-payload communications (CNPC) links, and seeks comment on various options. We expect the proposals and service rules upon which we seek comment in the *NPRM* will impose new or additional reporting or recordkeeping and/or other compliance obligations on small and other UA operators for access and use of the 5030-5091 MHz band spectrum. At this time however, the Commission cannot quantify the cost of compliance and cannot determine whether small entities will have to hire professionals to comply with the rule changes that may be adopted in this proceeding. With our request for comments on the band plan and service rules, we have also requested that parties file costs analyses to assist with the Commission's assessment of the rules that are under consideration. Below we discuss proposals in the *NPRM* and their potential compliance requirements for small and other entities to operate in the 5030-5091 MHz band.

19. *The Band Plan.* The *NPRM* proposes to partition the 5030-5091 MHz band to accommodate both non-networked radio-line-of-sight — or Non-Networked Access (NNA) — use cases, which can rely on direct communication links between an operator's controller and the unmanned aircraft (UA), and beyond-radio-line-of-sight — or Network-Supported Service (NSS) — use cases, which typically depend on network infrastructure to support communications between the operator and the UA. The *NPRM* proposes to dedicate a minimum of 10 megahertz of spectrum for NNA operations, and seeks comment on various options for the remaining 51 megahertz of spectrum, including dedicating 40 megahertz of spectrum for network-based NSS operations by dividing the spectrum into 4 licensed blocks of 10 megahertz each, and providing 11 megahertz for temporary additional spectrum available to either NNA-based operators or NSS licensees. The *NPRM* further proposes to permit only CNPC in the band, to define CNPC as any UAS transmission that is sent to or from the UA component of the UAS and that supports the safety or regularity of the UA's flight. It further proposes to provide that any entity, other than those precluded by section 310 of the Communications Act, will be eligible to obtain a 5030-5091 MHz NNA station or obtain a 5030-5091 MHz NSS license, and seeks comment on similarly restricting the eligibility of entities to operate NNA stations using assignments from a DFMS.

20. *Dynamic Frequency Management System.* The *NPRM* proposes that access to the band be managed by one or more dynamic frequency management systems (DFMSs). A DFMS would be a frequency coordination system that, in response to requests from registered NNA users, would determine and assign to the requesting user, through an automated (non-manual) process, temporary use of certain frequencies for a particular geographic area and time period tailored to the user's submitted flight plan.

⁵⁴ See Federal Aviation Administration, Department of Transportation, Remote Identification of Unmanned Aircraft, 86 Fed. Reg. 4390, 4494 (Jan. 15, 2021) (*Remote ID Rule*).

⁵⁵ See *id.*

The *NPRM* seeks comment on the appropriate regulatory framework to establish for a DFMS, including what requirements should be imposed on UAS operators in the band to help ensure a DFMS's ability to provide interference-free access. Among other possible requirements, the *NPRM* seeks comment on what information the operator should be required to provide regarding ground stations and unmanned aircraft stations, including whether an active UAS in the band should be required to submit information required by FAA's Remote ID rule, or some subset or variation of the information, and whether a UAS should be required to communicate to the DFMS, in real time or within a certain period of time of the relevant event, the initiation and termination of the flight or, alternatively, the initiation and termination of the operator's use of the assigned frequencies. Both of these potential rules would likely have reporting implications for small and other UAS operators, if adopted. The *NPRM* also seeks comment on whether to require UAS operators to register with a DFMS as a pre-condition of receiving NNA assignments and to provide certain information with such registration, which could also impact recordkeeping and reporting obligations. The *NPRM* proposes to authorize the administrator of a DFMS to charge UAS operators reasonable fees for its provision of services, including registration and channel assignment services, and to permit parties to petition the Commission to review fees and require changes if they are found to be excessive.

21. *NNA Service Rules.* The *NPRM* proposes to adopt service rules for NNA operations, including rules for licensing and technical requirements, and seeks comment broadly on the licensing regime or mechanism to enable authorization of NNA operations in the 5030-5091 MHz band and the costs and benefits of any proposed approach. For the licensing of stations in NNA spectrum, the *NPRM* proposes to adopt a licensed-by-rule authorization for aircraft and ground stations in the band. For technical requirements, the *NPRM* proposes to adopt the technical standard RTCA DO-362A or technical requirements based on this standard, which contains Minimum Operational Performance Standards for terrestrial-based (i.e., non-satellite) CNPC point-to-point or point-to-multipoint links in the 5030-5091 MHz band, including power limits, emission limits, and frequency accuracy requirements. In both the licensing eligibility and technical standards requirement discussions, we inquire whether to impose certification requirements that would likely be filed with the Commission, thereby impacting reporting requirements for users of the 5030-5091 MHz band.

22. We also seek comment on whether any of the general technical requirements in subpart D of part 87 of the Commission's rules should apply to NNA equipment, and whether to adopt any other requirements on NNA equipment to facilitate a DFMS's ability to communicate with or otherwise control such equipment in the execution of the DFMS's responsibilities. In addition, the *NPRM* seeks comment on the potential application of the generally applicable rules in subparts B through F of part 87, including whether to require each UAS operator using an NNA assignment in the 5030-5091 MHz band to have an operator license or permit. It further seeks comment on whether the new service should be subject to rules under part 1, subpart F governing "Wireless Radio Service" applications and proceedings. The application and/or incorporation of existing rules under part 87 or any other part of the Commission's rules would subject NNA users of the 5030-5091 MHz band to any applicable reporting and recordkeeping requirements under those rules unless explicitly excluded in the final rules.

23. *NSS Service Rules.* The *NPRM* also seeks comment on service rules for NSS licenses, including rules addressing, in particular, whether to issue geographic area defined licenses for a specific term of years, with rights of renewal. More specifically, the *NPRM* seeks comment on rules addressing (1) the geographic area scheme for licenses, (2) the appropriate initial and subsequent license terms, (3) performance requirements, (4) license renewal framework, and (5) technical and operational requirements.

24. For the geographic area of licenses, the *NPRM* seeks comment on whether to adopt larger licenses areas such as Regional Economic Area Groupings, a more granular scheme such as Partial Economic Areas, or a geographic division of the country developed specifically for aviation purposes. The *NPRM* proposes to issue NSS licenses for an initial 15-year term, and to limit subsequent terms to 10 years. The *NPRM* seeks comment on the appropriate standard for license renewal, and on whether the regulatory renewal framework for commercial geographic licensees of wireless radio services under part

1 of the Commission's rules is appropriate for NSS licensees. The *NPRM* also seeks comment on performance requirements, such as a requirement to cover 80 percent of the population within 12 years of license grant, and 45 percent coverage of the population within six years of license grant. For compliance demonstration, the *NPRM* proposes to adopt a process similar to compliance rules applicable to part 27 licensees, requiring licensees to file a construction notification with the Commission within 15 days of the expiration of the applicable benchmark, including submission of electronic coverage maps accurately depicting the boundaries of the licensed area and the boundaries of the actual areas to which the licensee provides service. For enforcement, the *NPRM* proposes that if a licensee fails to meet the final performance requirement, the license authorization will terminate automatically without specific Commission action, and that failure to meet the interim requirement would result in the reduction by two years of both the due date for the final performance requirement and the license term.

25. In the event that the Commission receives mutually exclusive license applications for NSS licenses, the *NPRM* proposes to assign these exclusive use licenses through a system of competitive bidding. Consistent with the competitive bidding procedures the Commission has used in previous auctions, the *NPRM* proposes to conduct any auction for geographic area licenses for spectrum in the band in conformity with the part 1, subpart Q general competitive bidding rules, subject to any modification of the part 1 rules that the Commission may adopt in the future. For small entities, the *NPRM* seeks comment on whether to make bidding credits available for eligible small businesses and rural service providers.

26. The *NPRM* also seeks comment on appropriate technical requirements for NSS licenses, and whether the technical standard RTCA DO-362A or equivalent technical parameters should also apply to NSS licenses. As an alternative to requiring NSS licensee compliance with the RTCA DO-362A standard generally, the *NPRM* also seeks comment on whether there are certain specific requirements of RTCA DO-362A that the Commission should minimally impose on NSS licensees to ensure compatibility with NNA operations, or for other purposes, such as the Time Division Duplex requirements of the RTCA DO-362A standard. In addition, the *NPRM* seeks comment on adoption of a field strength limit to prevent interference between adjacent geographic area licensees.

27. As with NNA service rules, the *NPRM* seeks comment on whether and to what extent the NSS service rules should incorporate or be subject to the requirements generally applicable to aviation services under subparts B through F of part 87 of the Commission's rules, either in their current form or with modifications, and whether the NSS service should be subject to rules under part 1, subpart F governing wireless radio service applications and proceedings. In particular, the *NPRM* seeks comment on whether to allow partitioning and disaggregation of NSS licenses as well as spectrum leasing. Likewise as mentioned earlier in the NNA service rules discussion, NSS users would be subject to any applicable reporting and recordkeeping requirements under existing Commission's rules incorporated into the requirements for the 5030-5091 MHz band. The *NPRM* also seeks comment on whether to authorize NSS licensees, at their discretion, to provide network-supported service for UAS CNPC through either a satellite or terrestrial network, or alternatively, whether the Commission should provide that certain NSS licenses are dedicated exclusively to satellite-based service. It further seeks comment on whether to permit NSS licensees to deploy High-altitude Platform Stations (HAPS).

28. *Equipment Authorization.* To ensure that equipment in the new band has the level of reliability and safety required of aviation equipment, the *NPRM* proposes to impose equipment authorization requirements similar to those under sections 87.145 and 87.147 of the Commission's rules to all equipment intended for use in the 5030-5091 MHz band. Section 87.145 requires that each transmitter must be certificated for use in the relevant service, and section 87.147 establishes a specific equipment authorization process. Section 87.147 specifically requires an applicant for certification of equipment to notify the FAA of the filing of the application, and provides that the Commission will not act on the application until it receives the FAA's determination regarding whether it objects to the application for equipment authorization.

29. *Protection of Other Services.* The *NPRM* seeks comment on any measures the Commission should adopt to protect federal Microwave Landing System (MLS) deployments in the 5030-5091 MHz band, and on whether to provide that no future non-federal MLS licenses (including MLS radionavigation land test licenses at 5031 MHz) will be granted in the 5030-5091 MHz band. To protect radio astronomy operations, the *NPRM* proposes, consistent with NTIA's recommendations, to continue to apply to the 5030-5091 MHz band the requirements of Footnote US211 of the Table of Frequency Allocations, and to prohibit UAS operations within the National Radio Quiet Zone (NRQZ) without prior coordination with the NRQZ administrator and submission of a concurrence from the NRQZ administrator with any request to a DFMS for frequency assignment within the NRQZ. The *NPRM* also seeks comment on applying to all UAS operations relying on the 5030-5091 MHz band in the NRQZ the licensee/applicant procedures for the NRQZ under section 1.924(a) of the Commission's rules, which include written notification filing requirements.⁵⁶ The *NPRM* further seeks comment on any special measures necessary to ensure compatibility between UAS operations in the 5030-5091 MHz band and AeroMACS and flight testing in adjacent bands. To protect radionavigation-satellite service in the 5010-5030 MHz band, the *NPRM* proposes to require 5030-5091 MHz operations to comply with the specific effective isotropically radiated power (EIRP) spectral density limit specified in Footnote 5.443C of the Table of Frequency Allocations. With regard to Canadian and Mexican coordination, the *NPRM* proposes to provide that all operations in the band are subject to international agreements with Mexico and Canada.

30. *Airborne Use of Flexible-Use Spectrum.* Regarding UAS operations in flexible-use spectrum, the Commission did not make specific proposals and seeks comment on the adequacy of its current rules to ensure co-existence of existing terrestrial wireless networks and UAS, and on the regulatory solutions that may be necessary to facilitate and encourage such use. Thus, at this time the Commission is not in a position to determine what rule changes could result from the questions raised in the *NPRM*, and which of those changes, if any, will result in reporting and/or recordkeeping obligations for small entities.

31. *VHF Licenses for UAS Pilots.* The *NPRM* proposes that the Commission individually license stations for UA pilot communication with control towers and other aircraft pilots under a new category of licensed station, an *Unmanned Aircraft Operator Ground VHF Station*, and to define the new station as "a station on the ground providing unmanned aircraft pilot radio communication relating to safety and regularity of flight on air traffic control, flight service station, unicom, or multicom frequencies." The *NPRM* further proposes to provide that these stations may operate over all air traffic control, flight service station, aeronautical advisory station (unicom) and aeronautical multicom channels authorized for use by aircraft. In addition, the *NPRM* proposes to permit mobile stations (stations intended to be used while in motion or during halts at unspecified points), and seeks comment on whether to permit non-mobile stations as well. Under this proposal, UAS operators would be required to file a license application with the Commission for an individual license covering their VHF station.

E. Steps Taken to Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered

32. The RFA requires an agency to describe any significant, specifically small business, alternatives that it has considered in reaching its proposed approach, which may include the following four alternatives (among others): "(1) the establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) the clarification, consolidation, or simplification of compliance or reporting requirements under the rule for such small entities; (3) the use of performance, rather than design standards; and (4) an exemption from coverage of the rule, or any part thereof, for such small entities."⁵⁷

⁵⁶ See 47 CFR § 1.924.

⁵⁷ See 5 U.S.C. § 603(c)(1)-(4).

33. In this proceeding, the Commission seeks comment on options to license the 5030-5091 MHz band for UAS CNPC. UAS operators have a growing need for the greater reliability of interference-protected licensed spectrum for CNPC, and the licensing of the 5030-5091 MHz band has the potential to provide UAS operators with access to interference-protected communications of sufficient reliability for operations where those communications links are safety-critical. As such access will support the growth of the UAS industry and help to realize its enormous potential economic and social benefits, the Commission anticipates that adoption of licensing rules for the band will have a significant positive economic impact on small and other UAS manufacturers, operators, and other stakeholders.

34. The Commission believes that applying the licensing rules equally to all entities will generally be necessary to protect the safety of life and property in air navigation and promote the efficient and intensive use of spectrum. However, to assist the Commission's evaluation of the economic impact on small entities and to better explore the alternatives in consideration of their economic impact on small entities as well as other factors, the *NPRM* has sought comment broadly on possible alternatives for a band plan and licensing rules, and requests information on the potential costs and benefits of such alternatives to small and other UAS operators. In addition, the *NPRM* has proposed or sought comment on certain specific options that may facilitate small entity access to spectrum in the band.

35. The *NPRM* proposes a band plan to support both NNA and NSS operations. We propose to partition the band, to dedicate different segments of spectrum in the 5030-5091 MHz band for NNA and NSS, and to license each of these segments in a manner that is appropriate to support the relevant use cases in order to accommodate both NNA and NSS users. We are also considering whether to make available spectrum for multi-purpose uses, e.g., expansion bands for temporary NNA or NSS use, and seek comment on this alternative. We seek comment on whether we should use a portion of the 51 megahertz for opportunistic use by both NNA or NSS licensees (multi-purpose use) or whether we should increase the amount of spectrum dedicated to NNA operations.

36. To the extent we dedicate spectrum for NSS licenses, we also seek comment on making that spectrum available for NNA operations on an interim, opportunistic basis. We seek comment on the costs and benefits of this approach, including its technical and economic feasibility, and on alternative approaches to ensuring productive usage of dedicated NSS spectrum prior to network deployment, which will help inform the Commission on the impact for small entities before adopting final rules. Further, as alternative approach to allocating spectrum in the band, we seek comment on alternative approaches to allocating the 5030-5091 MHz band for the support of UAS, including whether we should (1) allocate only a portion of the band at this time and defer allocation of the remainder of the band or (2) preserve part of the band at this time for experimental use, or for potential future satellite-based CNPC that relies on the AMS(R)S allocation in the band.

37. Ensuring the ability of the DFMS to provide interference-free access and promote robust and efficient use of the spectrum will most likely require the adoption of rules for NNA operators, including small operators. We seek comment on such requirements, including: (1) whether to require operators to provide ground station geographic location, effective isotropically radiated power (EIRP), and/or antenna patterns; (2) whether to require an active UAS relying on an NNA assignment in the band to provide a DFMS with the UA information that must be broadcast under the Remote ID rule or some subset or variation of the information; (3) whether a UAS operator should be required to affirmatively communicate to the DFMS, in real time or within a certain period of time of the relevant event, the initiation and termination of the flight or, alternatively, the initiation and termination of the operator's use of the assigned frequencies; and (4) whether there are other circumstances or information (aside from the request) that a UAS operator should be required by rule to communicate to the DFMS.

38. Interactions between the DFMS and UAS operators involving frequency assignment may require the Commission to adopt a registration process. Rather than propose a mandatory registration requirement before frequency assignments can be requested, we seek comment from small and other UAS operators on whether such a requirement is needed, and if so, what requirements should be imposed regarding registration. We seek comment on whether the Commission should simply require registration

and leave the details to be developed such as by the DFMSs or a multi-stakeholder group. We believe that allowing small UAS operators and other commenters to address this issue, including with cost data analysis, is the better approach to inform the Commission on the economic and other impacts for these operators. Similarly, regarding the submission of frequency requests, we consider what requirements, if any, should be imposed with respect to the submission of UAS operator requests for NNA frequency assignments, and alternatively what, if any, details of the request process should be left to be developed by a multi-stakeholder group. We also consider in the *NPRM* how to assist small and other operators if the need to revise their assignments arises after a flight has commenced by seeking comment on what, if any rules we should adopt to enable or facilitate the filing and timely processing of requests by the DFMS for revised assignments, or to otherwise address an operator's mid-flight need for revised assignment.

39. As part of the DFMS frequency coordination system, we have proposed and seek comment on allowing the DFMS administrator to charge reasonable fees for its provision of services, including registration and frequency assignment services, to UAS operators receiving the services. The Commission has taken steps to minimize the economic impact on small and other UAS operators by proposing to authorize UAS operators to petition the Commission to review DFMS fees and require changes if they are found to be unreasonable or excessive. Additionally, to encourage efficient use of the limited spectrum resource and discourage any attempt at warehousing which would likely disadvantage small UAS operators, we seek comment on specifically authorizing reasonable usage-based fees.

40. We also seek comment on potential alternatives to the DFMS proposal to enable dynamic spectrum access to the 5030-5091 MHz band, on the feasibility, costs, and benefits of alternative options as compared to the DFMS, and on whether such alternatives would be sufficiently reliable to support even the most safety-critical uses such as flights in controlled airspace.

41. The *NPRM* also proposes to implement licensing of NNA stations using licensed-by-rule authorization for both aircraft and ground stations in the band. Licensing by rule would reduce the burden on small entities and other UAS operators of obtaining direct access to protected spectrum for CNPC, as they would not be required to obtain individual spectrum licenses for themselves or their aircraft or ground UAS stations in order to operate in the 5030-5091 MHz band. In addressing the license rules for NSS operations, the *NPRM* seeks comment on issuing licenses on an exclusive geographic area basis. The *NPRM* also seeks comment on several options that may help to reduce the burden to small entities of obtaining and using such licenses or otherwise facilitate small entity access to this spectrum. First, while the *NPRM* seeks comment on defining license areas using large geographic areas such as Regional Economic Area Groupings (REAGs) (which divide the nation into twelve regional areas), it also seeks comment on using a more granular scheme, such as Partial Economic Areas (PEA), which may be more affordable or better tailored for small entities.

42. Second, the *NPRM* proposes certain measures to facilitate small entity participation in any competitive bidding process conducted for these licenses. Specifically, the *NPRM* proposes to conduct a competitive bidding process in the event that it receives mutually exclusive license applications. In order to promote and reduce the costs of participation for small service providers, the *NPRM* proposes to make bidding credits available for this band. A bidding credit of 15 percent for a qualifying "small business," defined as an entity with average gross revenues for the preceding five years not exceeding \$55 million, and a bidding credit of a 25 percent for a qualifying "very small business," defined as an entity with average gross revenues for the preceding five years not exceeding \$20 million have been proposed in the *NPRM*.⁵⁸ These proposed small business definitions and bidding credits are

⁵⁸ The standardized schedule of bidding credits provided in section 1.2110(f)(2)(i) of the rules defines small businesses based on a average gross revenues for the preceding three years. In December 2018, Congress revised the standard set out in the Small Business Act for categorizing a business concern as a "small business concern," by changing the annual average gross receipts benchmark from a three-year period to a five-year period. Thus, as a general matter, a federal agency cannot propose to categorize a business concern as a "small business concern" for Small Business Act purposes unless the size of the concern is based on its annual average gross receipts "over a

(continued...)

consistent with recent competitive bidding processes used by the Commission for assignment of licenses. The *NPRM* also seeks comment on whether to offer rural service providers a bidding credit for licenses in this band which would provide another opportunity for small providers who would qualify as rural providers to reduce their the costs of participation.

43. Third, the *NPRM* seeks comment on whether to allow partitioning and disaggregation of NSS licenses in secondary market transactions as well as spectrum leasing. Allowing these secondary market transactions could provide small entities with additional options for access to this spectrum, and may be an effective way to facilitate targeted network deployments, including by small entities.

44. In the *NPRM*, the Commission seeks comment on UAS operations on flexible-use spectrum using existing networks as platforms, which may offer small and other UAS operators a near term, low-cost option rather than requiring them to build-out a dedicated network for UAS operations. However, because existing terrestrial networks were not designed for UAS use, the Commission's terrestrial mobile service rules generally do not consider airborne use, and the introduction of UAS operations may result in increased interference. In light of the considerable stakeholder interest in UAS on flexible-use spectrum, and the Commission's commitment to allow flexibility in the use of existing spectrum and networks to the extent feasible, the Commission explores flexible-use as a potential option for UAS operations and seeks comment on the adequacy of its current rules to ensure co-existence of existing terrestrial wireless networks and UAS as well as on the regulatory solutions that may be necessary to facilitate and encourage such use. The Commission expects to more fully understand the feasibility of allowing UAS operations on flexible-use spectrum and the economic impact on small entities following its review of comments filed in response to the *NPRM*.

45. We also discuss adding a provision to part 87 of the Commission's rules to enable UAS operators to file an application with the Commission to obtain an individual VHF license under a new category of licensed station to address a need by some small and other UAS operators to communicate with ATC facilities in accordance with FAA rules. As mentioned in the prior section, in some instances the FAA requires UAS operators to communicate with ATC or with nearby manned aircraft over the VHF traffic control and advisory frequencies and to obtain a license from the Commission for this purpose. In the absence of provisions in the Commission's rules to provide such a license, the Commission handles such requests from UAS operators by granting special temporary authority on a case-by-case basis. The addition of the proposed licensing provision to part 87 will provide certainty of process and a more permanent operating authorization for small entities as compared to the special temporary authority the Commission uses for UAS operators to comply with the FAA's requirements. We anticipate that this proposal will help to facilitate the growth and safety of UAS operations by small and other entities.

46. Finally, the Commission expects to consider more fully the economic impact on small entities following its review of comments filed in response to the *NPRM*, including costs and benefits information and alternative proposals. The Commission's evaluation of the comments filed in this proceeding will shape the final alternatives it considers, the final conclusions it reaches, and the actions it ultimately takes in this proceeding to minimize any significant economic impact that may occur on small entities as a result of any final rules that are adopted.

F. Federal Rules that May Duplicate, Overlap, or Conflict with the Proposed Rules

47. Proposed UAS service rules for the 5030-5091 MHz band would, in part, overlap with and, depending on the UAS equipment requirements established in this proceeding, may be inconsistent

(Continued from previous page) _____
period of not less than 5 years." 15 U.S.C. § 632(a)(2)(C)(ii)(II), *as amended* by Small Business Runway Extension Act of 2018, Pub. L. 115-324 (Dec. 17, 2018); *see* 13 CFR § 121.903(a)(1)(ii). For consistency with the statutory requirements, we therefore propose to adopt the Small Business Act's revised five-year average gross receipts benchmark for purposes of determining which entities qualify for small business bidding credits.

with the FAA's Technical Standard Order (TSO) C213, which establishes minimum performance standards for UAS radios in the 5040-5050 MHz band.

APPENDIX C**List of Commenters*****AIA PETITION COMMENTS AND REPLIES***Comments

CTIA
Elefante Group
Integrity Communications Solutions Inc. (Integrity Communications)
Lockheed Martin Corporation (Lockheed Martin)
Raytheon Company (Raytheon)
RTCA Special Committee SC-228 WG2
Small UAV Coalition
The Boeing Company (Boeing)

Replies

Aerospace Industries Association (AIA)
AeroVironment, Inc. (AeroVironment)
CTIA
Rockwell Collins, Inc. (Rockwell Collins)

SECTION 374 COMMENTS AND REPLIESComments

AIA
Airbus Urban Mobility (AUM)
Aireon LLC (Aireon)
American Petroleum Institute (API)
AURA Networks (AURA)
Boeing
Commercial Drone Alliance (CDA)
Consumer Technology Association (CTA)
CTIA
Federated Wireless, Inc. (Federated Wireless)
Florida Power and Light Company (FPL)
General Atomics Aeronautical Systems, Inc. (GA-ASI)
GPS Innovation Alliance (GPSIA)
Iridium Communications Inc. (Iridium)
Lockheed Martin
Motorola Solutions, Inc. (Motorola)
Phirst Technologies, LLC (Phirst)
Small UAV Coalition
T-Mobile USA, Inc. (T-Mobile)
uAvionix Corporation (uAvionix)
WiMAX Forum

Replies

Aircraft Owners and Pilots Association (AOPA)
AUM
AURA
Aviation Spectrum Resources, Inc. (ASRI)
Boeing
Federated Wireless
National Public Safety Telecommunications Council (NPSTC)
Raytheon
Spectrum Financial Partners (SFP)
United Parcel Service, Inc. (UPI)
Verizon

REFRESH PUBLIC NOTICE COMMENTS AND REPLIESComments

AIA
AeroVironment
AURA
ASRI
Boeing
Canada's Notification Authority and Enquiry Point, Technical Barriers and Regulations Division
(Canada)
Commercial Drone Alliance (CDA)
CTIA
Dynamic Spectrum Alliance (DSA)
Edison Electric Institute (EEI)
Federated Wireless
FPL
L3Harris Technologies (L3H)
MatrixSpace Inc. (MatrixSpace)
National Telecommunications and information Administration (NTIA)
Northeast UAS Airspace Integration Research (NUAIR)
Northern Plains Unmanned Aircraft Systems Test Site (NPUASTS)
Qualcomm Incorporated (Qualcomm)
RTCA, Inc. (RTCA)
Shared Spectrum Company (SSC)
Small UAV Coalition
uAvionix
Wireless Innovation Forum (WInnForum)
Wisk Aero LLC (Wisk)

Replies

Federated Wireless
NTIA
Small UAV Coalition
Xcel Energy Services Inc. (Xcel Energy)

**STATEMENT OF
COMMISSIONER GEOFFREY STARKS**

Re: *Spectrum Rules and Policies for the Operation of Unmanned Aircraft Systems; Petition of AIA for Rulemaking to Adopt Service Rules for Unmanned Aircraft Systems Command and Control in the 5030-5091 MHz Band*, Notice of Proposed Rulemaking, WT Docket No. 22-323, RM-11798 (terminated)

I'm pleased to see us move toward unleashing more spectrum for unmanned aircraft systems (UAS).

As I've said before, this is an area where the United States can clearly lead with the right regulatory support. U.S. companies and research universities continue to incubate drone technologies at FAA-designated testing sites across the country—including in Nevada, where I previously visited a testbed to learn about the industry's vision and growing challenges. In 2021, we helped drive drone development through the establishment of FCC "Innovation Zones." We followed it up by refreshing the record on a path forward for drones in the 5030-5091 MHz band—which is the focus of our action today. As I said back then, "these systems cannot truly flourish without Commission action governing the operation of UAS in licensed spectrum," and getting there "will require careful work with our federal partners." Today, after close collaboration with NTIA and the FAA, we're proposing service and licensing rules to support robust, reliable, and safe UAS deployments in the 5 GHz band. That's real progress.

Of course, even as far as the Commission's role is concerned, securing a vibrant future for UAS isn't about just one frequency band. That's why I'm pleased to see us incorporate other critical issues related to drone operations into this notice of proposed rulemaking. Consistent with industry and academic interest and ongoing standards-setting efforts, we're exploring 5G as a UAS platform and the broader use of cellular bands for drone applications. We're also proposing a way to license drone communications with air traffic control.

UAS technologies pose plenty of potential, and their promise goes well beyond just package deliveries. They can aid disaster relief, protect critical infrastructure, enhance smart applications and precision agriculture, improve public safety, and even help us build more safely and efficiently. We're right to continue supporting their development, even as we also explore the unique policy challenges posed by their operation.

I am grateful to the Commission staff who developed this item. It has my full support.