

# COMMERCE SPECTRUM MANAGEMENT ADVISORY COMMITTEE (CSMAC)

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## Report of Unmanned Aircraft Spectrum Subcommittee:

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## DRAFT – REPORT

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**COMMERCE SPECTRUM MANAGEMENT ADVISORY COMMITTEE  
WORKING GROUP 4: UNMANNED AIRCRAFT SPECTRUM: DRAFT REPORT**

Date: January 14, 2021

**MANDATE**

The National Telecommunications and Information Administration (NTIA) mandate to the Commerce Spectrum Management Advisory (CSMAC) Working Group 4 (WG 4) is as follows:

- a. The FAA has the responsibility of ensuring the safe integrations of all classes of UAS into the national airspace, from small to large UAS. Spectrum to support command and control operations will be critical for these emerging industry applications, to include urban air mobility and transcontinental cargo delivery.
- b. What are appropriate models for ensuring timely and secure access to frequencies necessary to support UAS command and control requirements? What governance characteristics are important? Are there liability issues to consider for this function? Is it a 3rd party frequency coordinator model?
- c. What is the potential need to create an entity that supports and facilitates collaboration across the disparate federal advisory committees for UAS?
  - i. Develop alternative mechanisms and governance structures for such an entity

While the work of CSMAC has several commonalities with the current work on Section 374 of the FAA Reauthorization Act, comments to that separate proceeding are not included in the subcommittee's scope of work.

**APPROACH OF THE SUBCOMMITTEE**

To answer NTIA's questions, CSMAC initiated a concurrent, two-tiered approach. First, the subcommittee identified options for spectrum access mechanisms for Unmanned Aircraft System (UAS) and evaluated them in terms of advantages, disadvantages, and other observations. CSMAC approached this work to provide complementary, value-added contributions to ongoing activities in the UAS domain.

Second, the subcommittee examined the current state of the UAS environment and the committees supporting it. It looked at the landscape of various organizations and their scope of activities pertaining to UAS spectrum. The subcommittee then conducted interviews with advisory boards and other organizations and experts to supplement this information.

CSMAC planned a staggered start this term in an effort to help balance the workload across subcommittees. The WG 4 subcommittee commenced work on January 16, 2020, and typically met on a recurring two-week basis. During this time, the subcommittee held 27 meetings via teleconference. The sections below summarize the CSMAC WG 4 efforts and recommendations.

## INTRODUCTION

### THE UAS ENVIRONMENT

The current UAS<sup>1</sup> environment in the United States is in a dynamic state of development and innovation, with the technology having evolved at a rapid pace over the past 10 years. While many may see Unmanned Aircraft (UA) used as toys or a hobby, the commercial sector's development has continued to mature and, combined with federal agency usage, is the main driver of UAS technology. However, regulatory structures are needed to support UAS growth and safe integration into the National Airspace System (NAS), and this presents several policy and technical challenges. While spectrum allocations have been made available at the international and domestic levels, and several technologies have been certified by the Federal Aviation Administration (FAA) for use by UAS applications, the development of the necessary service rules for the deployment of Control and Non-Payload Communications (CNPC)<sup>2</sup> links have not yet been formalized.

The advancement of the commercial UAS industry has been assisted by the FAA Modernization and Reform Act of 2012, which enabled the 14 CFR Part 107 rulemaking effort that is now the basis for professional UAS pilot certification and operating rules for platforms less than 55 pounds. This has helped to enable UAs to be deployed into numerous commercial industry sectors, including goods delivery, media, agriculture, surveying, public safety, infrastructure, and entertainment to name a few. Package delivery has been one of the early successes for UAS, allowing urgent medical supplies to be more easily delivered during the ongoing COVID-19 pandemic.

These early applications are just the beginning of what the systems can achieve once they reach maturity and eventually operate nearly seamlessly with manned aviation in the same airspace with minimal restrictions. However, they can only reach this full capability with suitable spectrum infrastructure, such as spectrum access mechanisms and necessary regulations, enabled by appropriate regulations for spectrum access.

### TYPES OF UAS REGULATIONS CURRENTLY IN EFFECT

Pilot certification and operation of small UAS for Commercial Use (CFR 14, Part 107) has been the major focus of commercial UAS development since its introduction in 2016. Part 107 defines small UAS as “an unmanned aircraft weighing less than 55 pounds on takeoff, including everything that is on board or otherwise attached to the aircraft.” A large number of pilots have been certified for small UAS, restricted to Visual Line of Sight (VLOS).<sup>3</sup> However, the limits of Part 107 are well known and were never intended to foster full integration into the NAS; rather Part 107 is considered a crucial initial step to facilitate the deployment of small, unmanned aircraft at low altitude.<sup>4</sup> Full integration into the NAS requires a comprehensive regulatory regime that integrates UAS into current aircraft development and

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<sup>1</sup> UAS are known by many other names, including drones and Remotely Piloted Air Systems. This report uses the *UAS* terminology.

<sup>2</sup> A commonly used synonym for CNPC is Command and Control (C2). This report uses the *CNPC* terminology.

<sup>3</sup> 14 CFR 107.31 does restrict the operations of small UAS operating under Part 107 to within the pilot's visual line of sight. However, 14 CFR 107.33 allows visual observers to aid a remote pilot when the pilot's visual line of sight cannot be maintained. Importantly, 107.205 allows the FAA to waive 107.31 and 107.33 as well as seven other Part 107 operations rules. Such waivers can expand the types and applications of existing small UAS operations in the short term, but are not a long-term solution that can be scaled up to full operations at all times.

<sup>4</sup> [https://www.faa.gov/news/press\\_releases/news\\_story.cfm?newsId=18295](https://www.faa.gov/news/press_releases/news_story.cfm?newsId=18295)

certification to ensure that new UAS airframes are able to integrate safely across the NAS with both manned and unmanned platforms.

Many operators are now going beyond Part 107, pursuing certification options with FAA under CFR 14 Part 135 air carrier certification, allowing package delivery operations that can go beyond VLOS. Several companies have since been granted FAA certification for operation,<sup>5</sup> though this does not automatically clear the way for drone deliveries across the country. Airframes used for such deliveries are still required to receive an airworthiness certification, a flight operations certification, and a remote pilot certification, and operate on location-specific waivers from FAA.

To fly UAS heavier than the regulated 55-pound limit in Part 107, at the time of this report operators may apply for a determination from the Department of Transportation (DOT) under the Special Authority for Certain Unmanned Systems (49 U.S.C. §44807). Additionally, FAA has recently completed a rulemaking on Remote ID procedures and a public consultation on Section 374 of the FAA Reauthorization Act, addressing UAS CNPC links as well as Detect and Avoid and surveillance spectrum.

### **CNPC LINKS FOR UAS**

With the ongoing development of regulatory frameworks for UAS CNPC, no one clear definition (or even name) has been agreed on by all relevant domestic and international bodies. However, they all follow broadly the same intent as summarized by RTCA<sup>6</sup> in its work developing standards for FAA certification:

*Data and information sent to/from the Pilot Station and the UA for control of the UA and other safety-critical functions. It does not include any messages sent to achieve mission (payload) objectives.<sup>7</sup>*

The clarification of not including payload data is a key caveat for these links, as such data is not used for safety and may be significantly larger in size than the CNPC traffic. Dependent on the possible CNPC link, CNPC and payload communications may be separated by communications type, if not the software/security domain the communications links operate within. Only these communication types will be considered within this report.

Implementation of CNPC is currently split into two main fields: systems specifically designed from the start as UAS, and existing systems/networks that can be adapted to certain UAS requirements. While new systems may sound like a more optimal solution, existing systems may have established networks or technology that currently provides CNPC and therefore allows immediate access to UAS CNPC spectrum. This report considers all available options.

### **UAS CONSIDERATIONS FOR SPECTRUM**

UAS (and indeed all aircraft) have many different operational and regulatory requirements that can often dictate different spectrum requirements for other industries. For example, many aviation applications are considered safety-of-life/safety-of-flight, requiring additional regulatory and certification requirements over other commercial traffic. Additionally, numerous other considerations for different Communication, Navigation, and Surveillance (CNS) functions need to be accounted for when considering spectrum access mechanisms for UAS:

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<sup>5</sup> [https://www.faa.gov/uas/advanced\\_operations/package\\_delivery\\_drone/](https://www.faa.gov/uas/advanced_operations/package_delivery_drone/)

<sup>6</sup> Known formerly as the Radio Technical Commission for Aeronautics

<sup>7</sup> See RTCA DO-377 - Minimum Aviation System Performance Standards for C2 Link Systems Supporting Operations of Unmanned Aircraft Systems in U.S. Airspace

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- Aircraft can operate at all altitudes, and UAS can fly much closer to obstacles than traditionally larger, manned aircraft. This means long-range communications at altitude and also extremely low-level coverage are required.
- UAS mission types may range from automated activities confined to a small unrestricted area that can be under the supervision of a pilot within VLOS, up to long-range operation requiring direct control by a remote pilot in controlled airspace.
- Fully automated operation for brief or longer periods may compensate for the loss of the CNPC link, through either loss of coverage or interference issues.
- Smaller UAS may not have the size, weight, and power to accommodate all necessary transceivers, and either limit mission types, or need to use other technologies that were not specifically designed for UAS operation but still meet the operational and regulatory requirements.
- Use in different airspace classes for different types of missions will prescribe certain CNS needs for each airframe, dictating possible spectrum requirements, link/network availability, and access models available to meet the required approvals for the FAA safety case.
- The UAS communications infrastructure may be controlled by single or multiple entities, which may or may not require a standardized communications system design.
- The number of anticipated UAS could exceed the capacity of systems designed for traffic from manned aviation, so alternative systems may need to scale for the large number of UAS anticipated (such as the recent FAA decision on Automatic Dependent Surveillance - Broadcast (ADS-B)).
- Individual UASs may require spectrum access quickly (e.g., due to short-notice flights, changes to expected routes whilst in flight or use of alternate airports).
- Maintaining Positioning, Navigation, and Timing (PNT) functions is critical for existing airspace users, and UAS will need such functions to an even greater extent, especially for autonomous flight.

At the time of this report, two aeronautical allocations are being analyzed by the Federal Communications Commission (FCC) for domestic UAS CNPC spectrum rules, 960-1164, and 5030-5091 MHz,<sup>8</sup> both of which have domestic and international Aeronautical Mobile (Route) Service (AM(R)S) allocations but lack the domestic service rules necessary to use them. Additionally, the FAA and aviation industry have been reluctant to approve CNPC links in the 960-1164 MHz band at this time until concerns about interference to incumbent navigation and surveillance systems have been resolved. However, the 5030-5091 MHz band has no significant restrictions foreseen and will be available for deployment on ground infrastructure once FCC service rules have been approved in coordination with the National Telecommunications and Information Administration (NTIA).

### **FUTURE UAS DEVELOPMENT**

The current and future types of UAS will vary widely both by physical size and by application. This will likely include the replacement of some manned aircraft types for commercial cargo (and even passenger traffic with suitable public acceptance), conforming with existing FAA regulations to ensure safe

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<sup>8</sup> The 5030-5091 MHz AM(R)S and AMS(R)S allocation is limited to internationally standardized aeronautical systems and could technically be used by any aeronautical system meeting such requirement (both manned and unmanned). However, work at ICAO and aviation authorities within the US has focused on the band being dedicated for UAS links only.

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integration within the NAS and other aircraft. However, other applications that may not have been possible before, such as autonomous personal transport (e.g., Urban Air Mobility and Advanced Air Mobility<sup>9</sup>) and even sub-orbital space vehicles, are in development and expected to make significant headway in the near future. Each depends on the technology available, operational requirements, consumer demand, and suitable regulations.

The fast pace of development along with diversity of UAS applications has generated organic growth of the UAS development activities. There are many groups and activities working to advance UAS CNPC initiatives, including multiple government agencies and their federal advisory committees as well as other committees. Technical innovation, standards development, performance requirements, investment, pilot programs, regulation and policy, and integration activities are needed to safely advance UAS technologies and markets.

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<sup>9</sup> [https://www.faa.gov/uas/advanced\\_operations/urban\\_air\\_mobility/](https://www.faa.gov/uas/advanced_operations/urban_air_mobility/)

## UAS SPECTRUM ACCESS MODELS

### POTENTIAL SPECTRUM ACCESS MODELS

Based on information gathered and the subcommittee's own experiences, multiple spectrum access models have been identified and assessed as options for UAS CNPC links. These spectrum access mechanisms could apply to many bands, including some of them to the C-band AM(R)S and AMS(R)S allocation (5030-5091 MHz) that are the current focus of a petition for rulemaking at the FCC.

Using a particular spectrum access mechanism for UAS in one band does not preclude using other models in other bands. The solution might vary depending on UAS certification and might require multiple, overlapping approaches. It should be noted that both licensed and unlicensed options may be possible for different types of UAS applications. Licensed spectrum access models may be required to ensure safety and regularity of flight (subject to FAA approval), while unlicensed spectrum access might be acceptable in other cases.

The order of the spectrum access mechanisms presented below conveys no meaning or preference by the group, and while the subcommittee does recognize that certain mechanisms are more suited to certain UAS types and operations, it does not preclude mechanisms from being used for other UAS types and operations not specifically commented on.

The models/mechanisms considered are:

- Third-party coordinator
- Terrestrial commercial wireless networks
- Commercial satellite communications (SATCOM) networks
- Unlicensed access
- Dynamic spectrum access
- Band partitioning

### THIRD-PARTY COORDINATOR

**Overview:** An aviation spectrum expert third-party coordinator acts on behalf of FCC and NTIA to issue the necessary license authorization to transmit to UAS providers on a demand basis to terrestrial ground stations dedicated to UAS CNPC links. Each UAS would be assigned one or more frequencies (including alternate channels) along the planned route they intend to fly. The assignment process would use some combination of both automation and/or human in the loop, similar to how current aviation air-to-ground systems are currently managed in the Very High Frequency (VHF) band for Controller Pilot Datalink Communications (CPDLC). Both single or multiple third-party coordinators would be applicable for this model.

**Technology options:** Certified aviation UAS CNPC systems

**Existing examples of model:** Used to assign aviation frequencies for CPDLC and flight test functions, proposed frequency management organization discussed in RTCA DO-362

**Possible UAS types for which current model examples are best optimized:** Large UAS platforms required to fly at high altitudes and/or integrate with existing FAA controlled airspace

**Advantages of model:**



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- Proven model for current aeronautical air-to-ground communications that already has existing systems that have passed aviation certification/assurance for controlled airspace usage.
- Allows for a known and planned radio frequency (RF) environment.
- Allows for prioritization of public safety, high-value aircraft, etc.
- Assignments are based on worst-case location and propagation model assumptions, providing slack in the system for unexpected events without requiring a potential chain reaction of modifications.

### **Disadvantages of model:**

- Potentially large delay (hours to days) for coordination if using human-in-the-loop processing of assignments.
- Spectrum access inefficient as assignments are based on worst-case location and propagation model assumptions, leaving part of the band potentially unused.
- Aviation certification requirements and creating new ground infrastructure may increase the cost of access.
- Requires more than one assignment for each UAS to allow for alternate or backup frequencies and some type of link reestablishment process/protocol in cases when the link is lost due to interference.

### **Potential evolutions:**

- Automated system is envisaged to be website based for immediate access requirements, while long-term planning for permanent networks would require coordination with users.
- System would use pre-coordinated assignment criteria (co-site, propagation, etc.) to minimize processing overhead and maximize efficiency between users.
- The process would use a large number of automated machine-to-machine methods for frequency assignment management to reduce the time needed to approve requests, potential human errors, and costs.

## **TERRESTRIAL COMMERCIAL WIRELESS NETWORKS**

**Overview:** Commercial licensed wireless network providers use existing cellular networks to provide individual UAS connectivity within most wideband channels. Mobile services spectrum is traditionally licensed exclusively in some bands and shared in others, using deployed network infrastructure. Use of existing access control structure accommodates the coordination of spectrum, with each base station dynamically assigning the available frequency bands and resource blocks while each network's time/frequency access is automatically controlled by a single system.

**Technology options:** 4G/5G networks

**Existing examples of model:** Nationwide terrestrial carrier networks

**Possible UAS types for which current model examples are best optimized:** Small UAS

### **Advantages of model:**

- Nationwide networks already established and in operation.
- Use of global standards and existing roaming agreements means easier movement between regions/countries.

- Multi-band devices with the ability to roam to other established networks and commercial mobile bands outside of 5030-5091 MHz have inherent capacity and redundancy.
- Lower cost of entry with mass market of devices.

**Disadvantages of model:**

- Operational range and altitude for existing networks is designed for land-based users, not users at different altitudes or operating at significant speed.
- Limited to mobile technologies, which do not have UAS-specific protocol implementations at this time.
- Need to identify how UAS traffic on shared networks is protected and prioritized to required aviation certification standards and security.
- Mass market technology across a wide user base lowers the barriers to possible security incidents.
- Cannot guarantee channels or quality of service.

**Potential evolutions:**

- Physical network modifications could be implemented to provide additional coverage for UAS at altitude on a national basis.
- Improve the ability to guarantee channels and quality of service similar to public safety preferences.
- Development of specific UAS standards, protocols, and certification as part of the cellular UAS development process for networks to meet FAA certification and assurance requirements.

**COMMERCIAL SATCOM NETWORKS**

**Overview:** One or more commercial SATCOM providers use current and future satellite commercial networks to provide UAS connectivity within either dedicated or shared wideband channels. Use of existing commercial SATCOM access control structure accommodates the coordination of spectrum use, with necessary traffic management in place. Services can provide overlapping coverage in large areas, including areas not possible with terrestrial services such as remote or oceanic regions.

**Technology options:** Multiple nationwide and global coverage Geostationary Orbit (GSO) and Non-Geostationary Orbit (NGSO) constellations ranging from L to Ka bands

**Existing examples of model:** L-band services for Air Traffic Control, Aeronautical Mobile Satellite (Route) Service (AMS(R)S) and UAS C2, Ku/Ka SATCOM for commercial aircraft passenger services.

**Possible UAS types for which current model examples are best optimized:** Larger platforms flying at altitudes above the treeline in oceanic and remote areas, including within FAA controlled airspace

**Advantages of model:**

- Able to provide greater/more consistent coverage than terrestrial services.
- Signal coverage means easier movement between regions/countries.
- Time/frequency access automatically controlled by single system.
- Already has existing systems that have passed aviation certification and assurance for controlled airspace usage.
- Existing UAS systems are currently operating in AMS(R)S allocated spectrum.
- Provides a hybrid access mechanism in combination with other spectrum access models, for both extended coverage and contingency planning.

**Disadvantages of model:**

- Less robust coverage in urban canyons, etc.
- As with other access technologies, operation at frequency bands such as Ku/Ka SATCOM is susceptible to rain fade.

**Potential evolutions:**

- Development of smaller antennas that could support small UAS.

**UNLICENSED ACCESS**

**Overview:** All devices operate equally and are required to accept and mitigate interference on an equal basis, using a sensing capability that can help to overcome interference. Unlicensed rules can vary depending on band and purpose. Individual users need not be certified to operate in unlicensed spectrum.

**Technology options:** WiFi, Bluetooth, other Industrial, Scientific and Medical (ISM) band technologies

**Existing examples of model:** UAS and model aircraft used for recreational use

**Possible UAS types for which current model examples are best optimized:** Small UAS flying locally, such as in low population density areas and for non-safety-critical data

**Advantages of model:**

- Low cost of access to radio equipment.
- Low technical barrier to entry.
- Spectrum efficient by making use of all available access possibilities.
- Highly robust, since by its very nature it can be designed to overcome assignment errors and interference.
- Does not require a central coordination facility to manage implementation, network planning calculations, and assignments.

**Disadvantages of model:**

- Interference protection must not rely on regulatory guarantees, but by the devices' own design and planning.
- RF environments of unlicensed bands are variable and cannot guarantee reliability or availability.
- Not appropriate for safety-critical data, and may have certification issues even for other uses, given hazards to objects on the ground.
- No control over devices once in the mass market if changes required.
- Limited range based on power and usage restrictions for unlicensed bands.

**Possible evolution:**

- The policy/logic is controlled by a centralized database system to adjust system behaviors, performance, and enforcement measures as needed.

**DYNAMIC SPECTRUM ACCESS**

**Overview:** Radios look for available spectrum; each airborne radio link independently decides what secondary frequency to operate on, based on the detected local RF usage. Dynamic spectrum access models can utilize licensed and/or unlicensed spectrum and dictate Primary and Secondary UAS spectrum

users. Primary users are assigned a frequency by a Third-Party Coordinator or other method, while secondary use is on a non-interference basis to primary users.

**Technology options:** Acts as an overlay to existing communication technology

**Existing examples of model:** Citizens Broadband Radio Service (CBRS) Spectrum Access System (SAS), 5 GHz band Dynamic Frequency Selection (DFS)

**Possible UAS types for which current model examples are best optimized:** Emergency operations, operations in undeveloped regions, and scenarios with more UAS than available channels

**Advantages of model:**

- Could be more efficient means of RF usage than other models that do not grant access based on actual usage and propagation conditions.
- Does not require central coordination to mitigate network outages or unexpected operational changes.
- High robustness, can overcome assignment errors and interference.

**Disadvantages of model:**

- Increases UAV radio complexity to support necessary sensing.
- Need for technology updates to support detection of new signals as system develops.

**Possible evolution:**

- The core policy/logic is controlled by a centralized database system to adjust behaviors for sensing, cueing, and enforcement as needed.
- Coordination can be augmented through sensing, either terrestrial network and/or device-based sensing.

## **BAND PARTITIONING**

**Overview:** Partition band between different models is dependent on operational requirements. Sharing can be achieved by either frequency/band partitioning (with potential guard bands), or geographic separation (with potential separation distances). This option continues to be explored.

**Existing examples of model:** European proposal for joint SATCOM/terrestrial UAS CNPC system in 5030-5091 MHz.<sup>10</sup>

**Possible UAS types for which current model examples are best optimized:** Multi-role mission UAS flying between vastly different airspace types.

**Advantages of model:**

- Partitioning of a band to accommodate different system requirements.
- Possibly dynamically uses most robust technology depending on the propagation and coverage.

**Disadvantages of model:**

- Would require additional filters, transceiver complexity, and/or a guard band between the different technologies, which in turn may reduce the peak frequency band capacity.

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<sup>10</sup> CSMAC UAS Subcommittee understands that this proposal is currently being rescinded in Europe.

- Limited examples on UAS frequency band partition.
- Already predicted that existing spectrum capacity is not sufficient, let alone partitioning of the band, which may add additional spectrum restrictions.

**Possible evolution:**

- Dynamic partitioning may change based on usage requirements for each service, e.g., urban vs. rural.
- Additional studies would be warranted.

**FINDINGS ON SPECTRUM ACCESS MODELS**

CNPC spectrum access and management is critical to enabling safe integration of UAS into the NAS. In reviewing the multiple categories of UAS and their mission types, it is clear to the subcommittee that no single spectrum access mechanism is a solution to all possible UAS types expected. Furthermore, spectrum access mechanisms could apply to many different bands and technologies, requiring multiple, overlapping approaches. Several existing examples of the listed access models are dependent on the use of aeronautical safety allocations for the safety and regularity of flight, and therefore new spectrum access models for certain UAS types may require aeronautical safety spectrum allocations dependent on regulatory mandates by FAA (e.g., spectrum requirements, airworthiness certification, CNS equipage, and NAS requirements).

The eventual decision on the most appropriate CNPC link(s) depends on a calculus involving numerous parameters as noted in the introduction of this report, with several crucial differences to existing manned aviation requirements, such as level of automation or even the expected scale of UAS in the NAS. Important governance characteristics include safety assurance, spectrum access prioritization, enforcement, coordination, planning to assure link availability, continuity during handoffs, and contingency planning. There are different cost implications across the various models.

All spectrum access models considered in this report could have different potential liability issues, dictated by several factors including, but not limited to: the type of UAS utilizing the communications service, compliance with the relevant communications or other regulations under which the UAS is operating, and other relevant international, federal, or state laws impacting the operations of UAS. Compliance with FAA and FCC rules and regulations is likely to be a component of any liability issues for UAS operators, CNPC link service providers, and any third-party coordinators of specific spectrum access models.

The most important governance characteristic issues differ across classes of UAS. Those most important to large UAS differ from those most important to small UAS. A third-party frequency coordinator model could be appropriate for large UAS because of the greater certainty it provides through enforcement and prioritization. However, terrestrial commercial wireless might be better suited for small UAS because of its lower cost of entry and established nationwide networks already in operation. Commercial SATCOM networks could be appropriate for larger UAS flying above the treeline, especially in oceanic or remote areas, but could evolve to support small UAS via development of smaller antennas/new broadband satellite constellations and combined as a hybrid model with terrestrial commercial licensed wireless to extend coverage and contingency planning. Unlicensed spectrum access has a low cost of access and low technical barrier to entry and does not require central coordination, and so may be optimal for small UAS flying locally, such as in low population density areas and for non-safety-critical data. Spectrum access requirements will evolve, and spectrum access models should be flexible to accommodate different needs of the emerging UAS market.

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A third-party frequency coordinator maybe feasible for most of the various spectrum access models and might be required to manage multiple spectrum access mechanisms. It could help in managing individual assignments and/or various networks to ensure safety in line with FAA requirements. It could also support more seamless operations across multiple spectrum access models and greater flexibility to adapt as the UAS environment changes through market evolution.

The parameters that FCC and NTIA will need to incorporate into possible service rules for UAS spectrum are extensive, with multiple concurrent options present for different UAS types and missions. This is combined with an urgent need for action given the rate of UAS development, which will not be able to operate to its full capability without the necessary regulatory framework to provide suitable spectrum infrastructure.

Therefore, in determining how such spectrum access models may (or may not) be implemented, NTIA and FCC need to be informed in a timely manner of UAS spectrum requirements, including those necessary to satisfy safety requirements per FAA, and ensure coordination and integration across organizations and activities. Given the large number of various executive branch and federal agencies that may have input to such a process, a leadership role is needed to provide the necessary direction and resources to pull the various information together and then manage the output.

## FEDERAL ADVISORY AND OTHER COMMITTEES FOR UAS

This section highlights federal advisory<sup>11</sup> and other committees with ongoing and/or recent UAS activities: the FCC Technical Advisory Council (TAC), the FAA Drone Advisory Committee (DAC), UAS Executive Committee (ExCom), National Aeronautics and Space Administration (NASA) UAS Traffic Management (UTM) Pilot Program (UPP), and PNT Advisory Board. Based on inputs, the subcommittee has summarized their UAS activities below.

**FCC TAC:** FCC TAC provides technical advice to FCC to inform telecommunications policy. Its broad scope included a sub-group studying spectrum issues for UAS and identifying any areas that might require special attention or FCC spectrum management functions. Their activity was organized into three working groups: commercial systems, technology analysis, and spectrum analysis. The TAC finished its UAS work for the FCC in 2018. More details are available at <https://www.fcc.gov/general/technological-advisory-council>. There is currently no ongoing work on drones within the TAC.

**FAA DAC:** As stipulated in the DAC charter, the objectives and scope for the DAC is to provide independent advice and recommendations to DOT and FAA and to respond to specific taskings received directly from FAA. The advice, recommendations, and taskings relate to improving the efficiency and safety of integrating UAS into the National Airspace System. In response to FAA requests, the DAC may provide FAA and DOT with information that may be used for tactical and strategic planning purposes. Further information can be found at [https://www.faa.gov/uas/programs\\_partnerships/drone\\_advisory\\_committee/](https://www.faa.gov/uas/programs_partnerships/drone_advisory_committee/).

**UAS ExCom:** The UAS ExCom includes senior executives from FAA, Department of Defense (DOD), Department of Homeland Security (DHS), Department of Commerce (DOC), Department of Energy (DOE), Department of the Interior (DOI), Department of Justice (DOJ), and NASA. It provides a dynamic forum for federal agencies to share information on UAS research and development as well as policy and procedures for safe integration of UAS into the national airspace. The UAS ExCom and its two subcommittees—the UAS Integration Senior Steering Group (SSG) and the UAS Security SSG—are supported by the UAS Science and Research Panel (SARP), a group of member agency research experts who collaborate on sound technical approaches and partnerships across member agencies and the broader academic and science community. The SARP provides briefs and updates to the ExCom and SSGs. CSMAC is not aware of any spectrum activities within UAS ExCom.

**NASA UPP:** A 2016 law directed FAA to establish the UPP in coordination with NASA. The goal of the UPP is to define an initial set of industry and FAA capabilities required to support UTM at flight levels below 400 feet. UPP transfers NASA research to FAA with the intent of developing and demonstrating enterprise services to support automated UTM operations using a cloud service infrastructure and cooperative, community-based traffic management under FAA guidelines. These include Remote Identification to enable safe, routine drone operations “by allowing the public, the FAA, law enforcement, and Federal security agencies to identify UAS flying in their jurisdiction.”<sup>12</sup> Summaries and reports do not include discussion of spectrum bands. More information is available online at [https://www.faa.gov/uas/research\\_development/traffic\\_management/utm\\_pilot\\_program/](https://www.faa.gov/uas/research_development/traffic_management/utm_pilot_program/).

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<sup>11</sup> The Federal Advisory Committee Act (FACA) governs the operation of federal advisory committees.

<sup>12</sup> “UTM Pilot Program Background,” FAA and NASA (2019), available at [https://www.faa.gov/uas/research\\_development/traffic\\_management/utm\\_pilot\\_program/media/UPP2\\_Industry\\_Workshop\\_Handout.pdf](https://www.faa.gov/uas/research_development/traffic_management/utm_pilot_program/media/UPP2_Industry_Workshop_Handout.pdf)

**PNT Advisory Board:** The National Space-Based PNT Advisory Board advises on Global Positioning System (GPS)-related policy, planning, program management, and funding profiles relating to the current state of national and international satellite navigation services. Additional information on the PNT FACA is available at <https://www.gps.gov/governance/advisory/>.

## **FINDINGS ON FEDERAL ADVISORY AND OTHER COMMITTEES FOR UAS**

While there are disparate federal advisory and other committees with ongoing UAS activities, no committee is assuming leadership, specifically as a national focal point and centralizing function, on UAS spectrum. Instead of making spectrum decisions in isolation, NTIA and FCC need to be informed of UAS spectrum requirements and coordinate federal, nonfederal, and shared spectrum use. U.S. leadership is needed to provide direction, coordination, and integration for UAS spectrum activities across organizations, and to advance the way ahead. Therefore, the subcommittee concluded that there is a need to create an entity that supports and facilitates spectrum-related collaboration across the disparate federal advisory and other committees for UAS. CSMAC developed alternative mechanisms and governance structures for such an entity, summarized below.

## **ALTERNATIVE MECHANISMS AND GOVERNANCE STRUCTURES**

The subcommittee identified alternative mechanisms and governance structures to fill gaps identified and support and facilitate greater collaboration across federal advisory committees and their respective government agencies.

CSMAC determined that numerous organizations are working on UAS-related topics, but the work would be more efficient, effective, and impactful if more closely focused and aligned. A higher level of coordination on UAS issues and specifically spectrum usage is needed. Establishing a “north star,” via a mandate or other mechanism, would help diverse stakeholders pursue a common, overarching, and purposeful direction in the national interest.

Further, it is difficult to identify appropriate points of contact (POCs) given the multiple and varied operational and technical aspects of UAS. This observation was reinforced during our subcommittee work as we developed a landscape of various organizations and their scope of activities pertaining to UAS spectrum. A central POC who tracks and coordinates UAS activities and can provide “signposts” to the right POCs would be very useful. Therefore, there is a need to create an entity that supports and facilitates collaboration across the disparate federal advisory committees, and their respective agencies, for UAS.

CSMAC developed alternative mechanisms and governance structures for such an entity. These options are described below; the order presented conveys no meaning or preference by the group.

### **DESIGNATE A CENTRAL POC**

In this option, a central POC would be designated to coordinate information sharing and collaboration across federal agencies, industry, and academia and other non-profit organizations. This option includes the possibility of starting small and maturing over time into an office within a federal agency (see below).

### **ESTABLISH AN OFFICE WITHIN A FEDERAL AGENCY**

An office within a federal agency would help align, coordinate, and synchronize government, industry, and academic and other non-profit activities. It would convene stakeholders to bring together multiple perspectives and serve as an industry advocate within the executive branch in support of a whole-of-nation approach. While remaining light-touch and permissive, it would work toward effectively achieving



goals rationalized in advance. This governance structure is analogous to that of the Department of Commerce's Office of Space Commerce.

#### **CREATE A NEW EXECUTIVE STEERING COMMITTEE**

A new Executive Steering Committee would be created and charged with the responsibility of helping to reform how the various FACA groups might work in a more collaborative manner. This is a time-honored approach to providing a higher level of coordination across federal agencies. A federal government Executive Steering Committee on UAS could be established that includes representation from all relevant stakeholders—e.g., NTIA, FCC, NASA, FAA, DOD, DOC, DHS, DOJ, and DOI. This new Executive Steering Committee should be made aware of the activities of the various FACA groups working on UAS-related issues. If this Executive Steering Committee believes there is a need for a new organization beyond itself to coordinate the work, then it should charter this new entity. NTIA could serve as the initiator and call the first meeting for this new Executive Steering Committee.

#### **EXPAND THE CHARTER OF AN EXISTING FEDERAL ADVISORY COMMITTEE**

The scope of an existing federal advisory committee could be expanded to include supporting and facilitating collaboration across the disparate federal advisory committees for UAS. Federal advisory committees are chartered by various government organizations, and the mission and questions for each FACA group are provided by their parent organizations. Given this, although there are overlapping assignments for the groups, the groups themselves have very limited authority to identify or pursue efforts independent of directions provided by the organizations they support. Therefore, having an entity that provides, or even supports, collaboration across the FACA groups makes limited sense absent coordination at the level of the sponsoring government entities.

#### **EXPAND UAS EXCOM**

UAS ExCom could be expanded so that its scope of responsibilities includes coordination across the different federal advisory and other committees for UAS.

#### **ESTABLISH A NEW FEDERAL ADVISORY COMMITTEE**

A new federal advisory committee could be established to include coordination across all the existing federal advisory committees for UAS. However, this adds yet another FACA group.

## RECOMMENDATIONS

CSMAC's recommendations to NTIA are as follows:

1. Given the pertinence of UAS spectrum across various executive branch agencies, CSMAC recommends that NTIA play a leadership role in coordinating across federal government and providing direction and resources to facilitate UAS spectrum access. Specifically, CSMAC recommends that NTIA convene a group of federal stakeholders to gain consensus on spectrum requirements and to ensure that multiple spectrum access models and multiple bands can be leveraged to meet those needs. NTIA must coordinate federal agency uses of spectrum for UAS, inform FCC of federal agency UAS spectrum requirements in a timely manner, and work with FCC and FAA to ensure that the spectrum access models maximize industry's ability to offer terrestrial and satellite-based UAS solutions that are consistent with FAA safety requirements and FCC and NTIA regulatory requirements.
2. CSMAC recommends that NTIA initiate and champion designation of a central POC within the executive branch for UAS coordination—including spectrum—to facilitate information sharing and collaboration across federal agencies, industry, and academia and other non-profit organizations. One year after the establishment of this central POC, CSMAC recommends that NTIA assess if this option should be matured over time into an office within a federal agency. This office would convene stakeholders to bring together multiple perspectives and serve as an industry advocate within the executive branch in support of a whole-of-nation approach for UAS. While remaining light-touch and permissive, it would work toward effectively achieving U.S. goals rationalized in advance. It would serve as a standing coordinating committee to advance UAS.

**ACRONYMS**

AM(R)S – Aeronautical Mobile (Route) Service  
AMS(R)S – Aeronautical Mobile Satellite (Route) Service  
ADS-B – Automatic Dependent Surveillance - Broadcast  
C2 – Command and Control  
CDPLC – Controller Pilot Datalink Communications  
CFR – Code of Federal Regulations  
CNPC – Control and Non-Payload Communications  
CNS – Communication, Navigation and Surveillance  
CSMAC – Commerce Spectrum Management Advisory  
DAC – Drone Advisory Committee  
DHS – Department of Homeland Security  
DOC – Department of Commerce  
DOC – Department of Energy  
DOI – Department of the Interior  
DOJ – Department of Justice  
DOT – Department of Transportation  
ExCom – Executive Committee  
FAA – Federal Aviation Administration  
FACA – Federal Advisory Committee Act  
FCC – Federal Communications Commission  
GPS – Global Positioning System  
GSO – Geostationary Orbit  
ISM – Industrial, Scientific and Medical  
NAS – National Airspace System  
NASA – National Aeronautics and Space Administration  
NGSO – Non-Geostationary Orbit  
NTIA – National Telecommunications and Information Administration  
POC – Point of Contact  
PNT – Positioning, Navigation, and Timing

RF - Radio Frequency

SARP – Science and Research Panel

SATCOM – Satellite Communications

SSG – Senior Steering Group

TAC – Technical Advisory Council

UA – Unmanned Aircraft

UAS – Unmanned Aircraft System

UPP – UTM Pilot Program

UTM – UAS Traffic Management

VHF – Very High Frequency

VLOS – Visual Line of Sight

WG – Working Group