

CSMAC
Unmanned Aircraft Spectrum
Subcommittee 4

July 30, 2020



Subcommittee Members

- Carolyn Kahn, Co-Chair
- Andrew Roy, Co-Chair
- Audrey Allison
- Donna Bethea-Murphy
- Michael Calabrese
- Tom Dombrowsky
- Mark Gibson
- Mark McHenry
- Carl Povelites
- Dennis Roberson
- Mariam Sorond
- Bryan Tramont
- NTIA Liaisons: David Reed,
Richard Orsulak

Question:

Unmanned Aircraft Spectrum

- 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

Schedule

- Subcommittee kickoff: January 16
- Subcommittee meetings:
 - Scope & planning: February 24
 - Framework & initial inputs: March 11, March 25
 - Status updates: April 8, July 15, July 22
 - Working meetings: May 6, June 17
 - Report outline: May 27
 - Alternative C-band spectrum access mechanisms: July 1 & 15
- Interviews:
 - FCC TAC: April 29
 - RTCA (intro): June 24
 - Additional interviews requested

Two-Prong Approach

1. Examine current state of the UAS environment and the committees supporting it
 - Spreadsheet matrix of different organizations
 - Interviews with advisory boards to collect additional information
2. Identify options for spectrum access mechanisms for UAS
 - Possible solutions that may meet some/all of UAS requirements
 - Evaluation in terms of pros/cons & priorities

UAS Activities

	FCC Technological Advisory Council (TAC)	FAA Reauthorization Bill, Section 374	FAA Drone Advisory Committee (DAC)	International Civil Aviation Organization (ICAO)	NASA UAS Traffic Mgt (UTM) Pilot Program (UPP)	RTCA	3GPP
Purpose	Provides technical advice to the FCC, under FACA	Responds to Congress under Section 374 of FAA Reauthorization Act of 2018 (Public Law 115-254)	Provides FAA with advice on key UAS integration issues by helping to identify challenges and prioritize improvements	Builds consensus on international civil aviation standards and recommended practices and policies, under the UN	Develops, demonstrates, and provides enterprise services to support implementation of initial UTM operations	A standards development organization, including SC-228 which develops minimum operational performance standards (MOPS) for UAS	A standards organization which develops protocols for mobile telecommunications, including UAS 5G connectivity
Scope	Study the spectrum issues for UAS and identify spectrum useful for UAS C2	FAA, NTIA, and FCC to submit a report to Congress on use of 960-1164 MHz (L-band) and 5030-5091 MHz (C-band) for UAS operations	Create broad support for an overall UAS integration strategy and vision	Addressing spectrum planning for 5 GHz band, including UAS in 5030-5091 MHz; coordinating with ICAO RPAS Panel	Define initial set of industry and FAA capabilities to support UAS traffic mgt (UTM) at flight levels below 400 feet; transfers NASA research to FAA to support automated UTM operations	Development of aviation standards and supporting guidance material for FAA certified C2 links to be used by UAS operating in non-segregated, controlled airspace	3GPP TR 36.777 in Release 15 provides the results of a study on potential LTE enhancements for UAS; 3GPP RAN provided technical specs for LTE support of UAS
Spectrum	Aviation and non-aviation bands (incl. terrestrial mobile and unlicensed)	960-1164 MHz (L-band) and 5030-5091 MHz (C-band); other spectrum might be acceptable depending on safety case		Focus on licensed spectrum for operation	No discussion of spectrum bands in summaries or reports	960-1164 MHz (L-band), 5030-5091 MHz (C-band) and commercial SATCOM links	Commercial cellular bands
Access Models	Consider extension of Service Area Boundaries metric to higher altitudes	White space approach for L-band; need to identify access mechanism for C-band		Dedicated aviation spectrum for terrestrial links or detailed aviation performance models defined for commercial SATCOM links			



Potential Spectrum Access Mechanisms

- Third-party coordinator using manual and automated processes
 - Single or multiple coordinators
- Terrestrial commercial wireless networks
- Satellite commercial wireless networks
- Unlicensed
- Dynamic spectrum access
- Band partitioning

These spectrum access mechanisms could apply to many bands, including C-band (5030-5091 MHz). C-band is a focus of current work because it has appropriate allocations and is available for use, but access mechanisms need to be further defined.

Approach might vary depending on UAS classifications. Might require multiple, overlapping approaches.

Third-Party Coordinator

- Provides individual licensed assignments to each user/network on a demand basis using a combination of both automated and/or human in the loop
- System would use pre-coordinated assignment criteria (co-site, propagation, etc.) to minimize processing overhead
- Single or multiple third-party coordinators are both options for this model
- Possible UAS types that model best addresses: Large UAS, high altitude UAS
- Existing example of model: Current aviation VHF voice/datalinks, land mobile, Frequency Assignment Function (FAFu) model
- Potential evolution
 - Automated system is envisaged to be website based for immediate access requirements, while long-term planning for permanent networks would require coordination with users
 - Enforcement or disincentive options (pricing) options for potential spectrum warehousing

Terrestrial Commercial Wireless Networks

- Use of current and future terrestrial commercial wireless networks providing individual UAS connectivity within most wideband channels
- Mobile services spectrum is licensed exclusively, using deployed network infrastructure
- Use of existing access control structure accommodates the coordination of spectrum use
- Technology options include 4G/5G
- Potential evolution
 - Modifications could be required to provide coverage for UAS

Satellite Commercial Networks

- Use of current and future satellite commercial networks
- Variety of approaches exist
- Use of existing access control structure accommodates the coordination of spectrum use
- Provide safe and reliable C2 in places where there is not terrestrial/unlicensed coverage
- Provides a dissimilar redundancy
- Can offer services in frequency bands that have safety allocations requiring allowing for priority and preemption services

Unlicensed

- All devices operate equally and are required to accept and mitigate interference on an equal basis
- Existing example of model: WiFi, Bluetooth, ISM
- Possible UAS types that model best addresses: Small UAS
- Potential evolution
 - The policy/logic is controlled by a centralized database system to adjust behaviors for and enforcement as needed

Dynamic Spectrum Access

- Radios look for available spectrum; each airborne radio link independently decides on what secondary frequency to operate on based on the detected local RF usage
- The spectrum band has both Primary and Secondary UAV spectrum users
- Primary users are assigned a frequency by a Third-Party Coordinator or other method
- Secondary use is on a non-interference basis to Primary use
- Existing example of model: Dynamic Frequency Selection used in the 5 GHz band
- Potential evolution
 - The core policy/logic is controlled by a centralized database system to adjust behaviors for sensing cueing, and enforcement as needed

Band Partitioning

- Partition band between different models dependent on operational requirements
- Sharing of above concepts via either:
 - Frequency / Band Partitioning (with potential guard bands)
 - Geographic separation (with potential separation distances)
- Partitioning may change based on usage requirements for each service, e.g. urban vs. rural

Interim Observations

- CNPC spectrum access and management is critical to enabling safe integration of UAS into the NAS
- Spectrum needs vary based on the complexity of UAS use cases
 - Multiple categories of UAS and mission types means no single solution is applicable to all
 - UAS comms decisions could depend on a calculus involving parameters such as: flight path, cost, network availability and level of required preemption standards and may include multiple options
 - Spectrum access mechanisms could apply to many bands; might require multiple, overlapping approaches
- NTIA/FCC need to be informed of UAS spectrum requirements and ensure coordination and integration across organizations and activities
- U.S. leadership is needed to provide direction and a way ahead
- Need to establish access granting mechanism and service rules
 - Market/flexible vs rules/prescriptive approach
 - To enable development of new UAS services quickly

Next Steps

- Conduct interviews: February 2020 – September 2020
- Analyze information and develop a draft report: August 2020 – November 2020
- Iterate interim findings and conduct follow-on work: December 2020 – February 2021
- Deliver report and recommendations to NTIA: March 2021

BACK-UP

Definitions: UAS CNPC and C2

Control and Non-Payload Communications (CNPC)

- ITU-R: The radio links, used to exchange information between the UA and UACS, that ensure safe, reliable, and effective UA flight operation¹
 - Includes telecommand messages, non-payload telemetry data, support for navigation aids, air traffic control voice relay, air traffic services data relay, target track data, airborne weather radar downlink data, non-payload video downlink data
- FCC TAC: Includes C2, detect and avoid, air traffic management, etc.²
- RTCA: 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) objectives³

Command and Control (C2)

- ICAO: The data link between the remotely piloted aircraft and the remote pilot station for the purposes of managing the flight⁴
- FAA: The link between the ground control station and the small unmanned aircraft⁵

Considerations

- Spectrum requirements for UAS differ from other non-aviation uses/bands because of its complex environment
 - Safety-of-life / safety-of-flight
 - Altitude
 - Mission
 - Operational types
 - Size
 - Multiple communication needs
 - Scaling problem with large number of UAS anticipated
 - PNT requirements

Advisory Board Interviews

- Intended to conduct interviews with relevant federal advisory boards
 - Looking at potential other industry groups that may provide benefit
- Interviews will focus on three areas:
 - Advisory board functions and activity
 - CNPC development
 - UAS spectrum considerations

Current State of the Environment

- Overview of the environment
 - Definitions
 - Complexities
 - Spectrum access
 - Classes of systems
 - Standards
 - Ongoing efforts / scope of activities
- CNPC functions
- Spectrum options
- UAS spectrum access
 - Frequency access models
 - Governance/ownership
 - Security/interoperability
 - Liability issues
 - Licensing