DRONE ACCESS TO AIRSPACE

Report of the Drone Advisory Committee

Final Report – November 2017

Drone Access to Airspace

1. Executive Summary

Task Group 2 (TG2) of the Drone Advisory Subcommittee (DAC SC) was assigned the task of providing recommendations to FAA for near term steps (within 24 months) that will enable new UAS use cases via greater airspace access within the National Airspace System. This report provides five final recommendations as well as insights into the thinking and methodology of TG2 members.

The summary and recommendations reflect an iterative process involving first task group consensus, then DAC SC approval, and finally affirmation by the DAC to ensure the final product is aligned with the input of all those groups. The first set of interim recommendations were presented to the DAC on 3 May 2017 where there was general consensus on most of the items presented with two minor recommendations: First it was recommended we change the tone of the recommendations to FAA and make them more advisory rather than directive in nature. Next it was recommended we modify our command/control (C2) technology-specific recommendation (recommendation 3) to be more technology neutral. Modifications to the draft recommendations were made, consensus was attained within TG1 on the modified recommendations, and final recommendations reported to the DAC SC, which gave its approval on 8 June 2017 and recommended these comprise our final recommendations to the DAC.

2. Background

During its inaugural meeting on September 18, 2016, the DAC members discussed the need to work collaboratively with the FAA to provide consensus-based recommendations on issues related to the integration of UAS into the nation's airspace. Based on those conversations, the FAA requested the DAC's assistance in developing consensus recommendations regarding the operational priorities to achieve full integration of UAS into the NAS. A DAC Task Group was established in November, 2016, under the DAC Subcommittee, and its members worked with the FAA to develop a task statement for this work, which was approved by the DAC during its January 2017 meeting. The FAA requested that the DAC respond with recommendations on some or all the questions posed in its task statement by the May 2017 meeting of the DAC

3. Scope

Federal Aviation Administration (FAA) developed a roadmap to ensure the safe and efficient integration of Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS). During the past several years, the Agency has been fully engaged working across a variety of platforms, multiple types of operations, and different classes of airspace to provide a structured approach to UAS integration. FAA requested the DAC's assistance in developing consensus recommendations regarding the operational priorities to achieve full integration of UAS. The DAC is asked to provide recommendations on UAS operations/missions beyond those currently permitted, and define procedures for industry to gain access to the airspace. These additional operations should be achieved within the next 24 months through a risk-based approach to gaining operational approval and certification based on FAA regulations and guidance. The near-term recommendations should be easily achievable and use existing public/private infrastructure to the greatest extent possible. The Task Group should provide additional recommendations on expanded access for UAS operations/missions that may require public/private infrastructure, rulemaking, and or other changes that would extend implementation beyond the 24-month time frame (e.g. missions/operations in Class-B Airspace requiring interactions with ATM systems).

Important for the Task Group's frame of reference is an awareness that the FAA aircraft certification philosophy is evolving to make it more responsive to rapidly changing technology, using a risk-based approach to accommodate new mission types.

Specifically, the FAA asked the DAC (via TG2) to advise on the following issues regarding airspace access for UAS:

- Provide recommendations for roles and responsibilities for the UAS, the remote pilot, the operator, and air navigation service provider.
- Provide recommendations for safe, expedited UAS airworthiness and operational approvals where required, for the various near-term (within 24 month) UAS missions.
- Provide recommendations on minimum essential aircraft equipage, public/private infrastructure needs, and operational requirements beyond those currently permitted (such as under 14 Code of Federal Regulations Parts 101 and 107) to include information flow and interoperability considerations.
- Provide recommendations on methods of communications for command and non-payload communications – specifically, how these requirements may vary among the likely near-term UAS missions.

The FAA requested final recommendations to be presented at the October 2017 DAC meeting. The complete task statement is included in Appendix a) of this document

4. Assumptions and Guiding Principles

- TG2 will NOT deal with anything addressed by Parts 101 and 107 that does not require a waiver
- TG2 will NOT necessarily result in FAA certification requirements
- TG2 will address how this work relates to work of UTM RTT groups
- TG2 will NOT be vehicle- or design-specific
- TG2 will develop a tiered approach to access based on risk, industry need, and ease of implementation, to determine which categories should be addressed within the next 24 months
- TG2 will develop use cases for these near-term categories and define minimum requirement for airspace access for these cases

5. Methodology

Task Group 2 is composed of approximately 70 members (23 of which are voting representatives) from a cross-section of stakeholder groups with relevant industry experience to include many who have been engaged in planning and implementing various aspects of unmanned aircraft manufacture, application, and operations. They include operators, pilots, controllers, automation providers, technical advisors, and a diverse set of FAA Subject Matter Experts who provided leadership in UAS Integration, Air Traffic Services, NextGen planning, pilot and demonstration programs, and UAS regulatory implementation.

The following is a short summary of the approach and methodology used by Task Group 2 to develop this final report:

Collaborate/Educate

- *Coordinated trajectory, aim points with TG2 members & FAA. Meetings with FAA ATO*

- *Multiple education sessions held with FAA on airspace classifications and access requirements, status of waivers, and certification requirements for commercial UAS operations*
- *Presentations of UAS use cases and assumptions provided for initial consideration*

Build and Leverage Consensus

- Initial consensus reached to focus on two use cases based on market needs, ease of implementation, and safety risk to the NAS
- *Five focus groups created to address issues of:*
  - *Low altitude operations within the Mode C Veil*
  - *Equipage requirements*
  - *Leveraging existing cellular networks for C2*
  - *Operational and airworthiness certification requirements for commercial UAS BVLOS operations*
  - *Future needs for airspace access beyond the 24 month timeframe*
- *Five issue papers generated by focus groups addressing issues above*
- *Balloting held on five issues papers to confirm consensus & highlight outstanding issues*
- *Follow-up and re-balloting conducted, and 100% consensus achieved on all issues papers*

Make Rapid Progress

- *Avoid temptation to "get technical"*
- *Maintain focus on assumptions and guiding principles, timeline & deliverables*

6. Final Recommendations to the FAA

1. Prioritize sUAS BVLOS operations within the Mode C Veil below 400 ft AGL.

Recommend FAA prioritize BVLOS UAS operations in Class B airspace, below the obstacle clearance surfaces (OCS) for either the airport itself or any instrument approach to the airport. Within this volume of airspace, equipage requirements exist for nearly all aircraft, thus enabling cooperative aircraft separation and Part 107 BVLOS and commercial UAS BVLOS operations.

Section 1, Appendix D of 14 CFR 91, Airports/Locations: Special Operating Restrictions refers to operating restrictions in Class B airspace. These operating restrictions apply below 10,000 feet MSL within a 30-nautical-mile radius of each location of airports listed in Section 1: https://www.gpo.gov/fdsys/pkg/CFR-2001-title14-vol2/xml/CFR-2001-title14-vol2-part91-appD.xml

2. Develop technology neutral navigation performance requirements.

Recommend the FAA establish, evaluate and implement performance-based navigation requirements for low altitude BVLOS operations within the Mode C Veil, the result of which will promote integrated BVLOS airspace operations with shared intent, position data, and other information to help UAS operators/pilots maintain awareness of other aircraft as well as remaining in their approved operating volume.

3. Evaluate the minimum requirements needed to meet low altitude UAS C2 operations.

Recommend the FAA sponsor a program to evaluate the viability of existing commercial technologies and networks in the context of performance-based C2 (command and control) standards and concepts of operation. The FAA should consider leveraging the work of industry groups.

As part of this program recommend FAA sponsor an operational prototype that includes different connectivity options including cellular. Within this prototype, the FAA should pursue the opportunity to pull data directly from other industry trials

4. Establish a FAR Part 135 regulatory "pathfinder" program (and draw upon findings from other pathfinder programs) for commercial UAS low-altitude (<400') BVLOS operations

Recommend the FAA create a well-defined pathway, derivative of Part 135 and other related requirements for air carrier operations and operations for compensation and hire, that are specific to UAS and that enable low-altitude BVLOS commercial operations.

Upon the conclusion of this regulatory pathfinder program, recommend FAA promulgate further guidance in the form of an Advisory Circular and include a Part 135-derivative process path for operational approval.

5. Beyond 24 Month Timeframe Recommendations

Recommend FAA conduct an analysis of, at a minimum, FAR Part 91 and Part 77 as a basis for the creation of a new set of operational rules which provide the operational flexibility of Visual Flight Rules, while operating with reference to displays and instruments without natural visual reference to a horizon. This analysis must consider visibility, distance-from-clouds criteria, equipage, and communication requirements related to dynamic operations in Class G and Class E (including "Upper E") airspace, specifically above 400 ft AGL.

This analysis should also consider the impact of a UTM capable of providing separation between (i) UAS with other UAS and (ii) UAS with other manned aircraft independent of Air Traffic Control.

7. Appendices

a) FAA Tasking Statement

b) List of TG2 participants (voting members)

c) Matrix charts of UAS use cases and assumptions

d) Approved Issues Papers

U.S. Department
of Transportation
**Federal Aviation
Administration**

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**Drone Advisory Committee (DAC) – Task Group (TG) 2
Recommended Tasking on Access to Airspace
January 31, 2017**

ACTION: Topics for discussion and analysis for DAC Subcommittee (DACSC) TG on access to airspace.

SUMMARY: As you know, the Federal Aviation Administration (FAA) has developed a roadmap to ensure the safe and efficient integration of Unmanned Aircraft Systems (UAS) into the National Airspace System. During the past several years, the agency has been fully engaged working toward the integration across a variety of platforms, multiple types of operations, and different classes of airspace to provide a structured approach to UAS integration. Since the agency established the DAC last fall, the aviation community has expressed interest in working with the DAC to develop and provide the FAA consensus-based recommendations on issues related to UAS based on discussion at the DAC's September 2016 "kickoff" meeting, the FAA requests the DAC's assistance in developing consensus recommendations regarding the operational priorities to achieve full integration of UAS.

Specifically, we seek greater input on a range of guidance material, and we believe that the DACSC is an appropriate forum to obtain industry input and perspective. We understand the DACSC, in response to direction from the DAC, has established an Access to Airspace TG. The tasking outlined in this letter is intended to facilitate the DACSC's focused and sequential review of UAS integration/access issues. It is intended that follow-on taskings will be provided as needed for additional focus and direction in order to achieve measurable progress on airspace access issues by the end of 2017.

TASK: Create an Access to Airspace TG to provide recommendations on UAS operations/missions beyond those currently permitted, and define procedures for industry to gain access to the airspace. These additional operations should be achieved within the next 24 months through a risk-based approach to gaining operational approval and certification based on FAA regulations and guidance. The near-term recommendations should be easily achievable and use existing public/private infrastructure to the greatest extent possible. The TG should provide additional recommendations on expanded access for UAS operations/missions that may require public/private infrastructure, rulemaking, and or other changes that would extend implementation beyond the 24-month time frame (*e.g.*, missions/operations in Class-B Airspace requiring interactions with Air Traffic Management (ATM) systems).

Important for the TG's frame of reference is an awareness that the FAA aircraft certification philosophy is evolving to make it more responsive to rapidly changing technology and using a risk-based approach to accommodate new mission types. To facilitate completion of the work, the TG will reference material produced by RTCA, NASA and the FAA; including UAS operational scenarios, the UAS Traffic Management (UTM) pilot project, Pathfinder progress to date; appropriate RTCA special committee Minimum Aviation System Performance Standards (MASPS)/Minimum Operations Performance Standards for Global Positioning System (MOPS), and recommendations; and the like.

Develop Recommendations

The TG will:

1. Provide recommendations for roles and responsibilities for the UAS, the remote pilot, the operator, and air navigation service provider;
2. Provide recommendations for safe, expedited UAS airworthiness and operational approvals where required, for the various near-term (within 24 months) UAS missions;
3. Provide recommendations on minimum essential aircraft equipage, public/private infrastructure needs, and operational requirements beyond those currently permitted (such as under 14 Code of Federal Regulations Parts 101 and 107) to include information flow and interoperability considerations; and
4. Provide recommendations on methods of communications for command and non-payload communications – specifically, how these requirements may vary among the likely near-term UAS missions.

SCHEDULE: The FAA requests an interim set of recommendations at the May 2017 DAC Meeting, followed by a final report no later than the October 2017 DAC Meeting. The FAA will make subject matter expertise available to the DAC upon request.

FOR FURTHER INFORMATION CONTACT: Victoria Wassmer, Deputy Administrator (A), Chief NextGen Officer and DAC Designated Federal Official, at 202-267-8111.

Issued in Washington, DC, on February 10, 2017.

Victoria B. Wassmer
Deputy Administrator (A), Chief NextGen Officer
and DAC Designated Federal Officer

Task Group 2 Voting Members

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Co-Chair Hughes, Robert	*Northrop Grumman*
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Bahrami, Ali	*AIA*
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UAS Use Cases and Assumptions

UAS Mission Type	Operations Over People (Public Events)	Rural, Contained Area Operations	Rural, Linear Operations	Suburban/Urban (Dynamic Operations)	Small Cargo (Networked Operations)	Medium Cargo	Large Cargo	HALE
Traffic Management Responsibility	ATC Authorization as Required	- ATC Authorization as Required	- ATC Authorization as Required	- ATC Authorization as Required	- ATC Authorization as Required - FAA procedures and rules for these operations	- IFR operation, under ATC control - FAA procedures and rules for UAS unique issues (e.g., lost link contingency)	- IFR operation, under ATC control - FAA procedures and rules for UAS unique issues (e.g., lost link contingency)	- IFR operation, under ATC control - FAA procedures and rules for UAS unique issues (e.g., lost link contingency)
UAV Automation Responsibility	- None	Ability to detect manned aircraft and notify UAS remote pilot (in non-cooperative airspace)	Ability to detect manned aircraft and notify UAS remote pilot (in non-cooperative airspace)	Ability to detect manned aircraft and notify UAS remote pilot (in cooperative airspace)	- Ability to detect and avoid aircraft, people, and structures (yield right-of-way to manned aircraft) - Ensure safety of cargo carriage and delivery	- Ability to detect manned aircraft and notify UAS remote pilot - Ability to conform to FAA UAS procedures (e.g., lost link contingency procedures)	- Ability to detect manned aircraft and notify UAS remote pilot - Ability to conform to FAA UAS procedures (e.g., lost link contingency procedures)	- Ability to detect manned aircraft and notify UAS remote pilot - Ability to conform to FAA UAS procedures (e.g., lost link contingency procedures)
Operator Responsibility	- Request Authorization - UAS maintenance - Insurance - Remote pilot training	- Request Authorization - UAS maintenance - Insurance - Remote pilot training	- Request Authorization - UAS maintenance - Insurance - Remote pilot training	- Request Authorization - UAS maintenance - Insurance - Remote pilot training	- Develop procedures & infrastructure for UAS networked operations, to be approved by FAA - UAS maintenance - Insurance - Remote pilot training	- File IFR Flight Plan - UAS maintenance - Insurance - Remote pilot training	- File IFR Flight Plan - UAS maintenance - Insurance - Remote pilot training	- File IFR Flight Plan - UAS maintenance - Insurance - Remote pilot training
Remote Pilot Responsibility	- Must avoid aircraft, people, and structures	- Must avoid aircraft, people, and structures (yield right-of-way to manned aircraft)	- Must avoid aircraft, people, and structures (yield right-of-way to manned aircraft)	- Must avoid aircraft, people, and structures (yield right-of-way to manned aircraft)	- Must avoid aircraft, people, and structures (yield right-of-way to manned aircraft)	Follow normal IFR procedures	Follow normal IFR procedures	Follow normal IFR procedures
Other Aircraft Responsibility	- Comply with NOTAMs	- Comply with NOTAMs	- Comply with NOTAMs	- Comply with NOTAMs - Must broadcast own position	- Comply with NOTAMs - Must broadcast own position	- Comply with NOTAMs - Must broadcast own position	- Comply with NOTAMs - Must broadcast own position	- Comply with NOTAMs - Must broadcast own position
UAS Equipage (other than DAA & C2)	Injury Mitigation (e.g. parachute)	Ability to remain within contained area (e.g., geofencing)	Ability to remain within linear area (e.g., geofencing)	Ability to avoid restricted/prohibited areas and airspace (e.g., geofencing)	Ability to avoid restricted/prohibited areas and airspace (e.g., geofencing)	Must meet IFR aircraft equipage requirements	Must meet IFR aircraft equipage requirements	Must meet IFR aircraft equipage requirements
FAA Infrastructure Needs	ATC authorization/ notification capability	ATC authorization/ notification capability	ATC authorization/ notification capability	ATC authorization/ notification capability	ATC authorization/ notification capability	ATC - UAS Pilot Communications	ATC - UAS Pilot Communications	- Flight Plan filing for unique UAS flights - ATC - UAS Pilot Communications
UAS Operator Infrastructure Needs	As needed for operation	As needed for operation	As needed for operation	As needed for operation	- Cleared landing areas at delivery sites - FAA-approved UAS cargo "hubs" - UAS fleet management system	Operator ability to file IFR flight plans	Operator ability to file IFR flight plans	Operator ability to file IFR flight plans
Information Flow	- UAS Operator - FAA (for authorization) - Remote Pilot - UAV	- UAS Operator - FAA (for authorization) - Remote Pilot - UAV	- UAS Operator - FAA (for authorization) - Remote Pilot - UAV	- UAS Operator - FAA (for authorization) - Remote Pilot - UAV	UAS Operator - FAA	- UAS Operator - FAA - Remote Pilot - ATC - Remote Pilot - UAV	- UAS Operator - FAA - Remote Pilot - ATC - Remote Pilot - UAV	- UAS Operator - FAA - Remote Pilot - ATC - Remote Pilot - UAV
Interoperability	Limited	None	Limited	Medium	Significant	Same as manned aircraft	Same as manned aircraft	Same as manned aircraft
CNPC Equipage and Spectrum Needs	Unlicensed spectrum or LTE	LTE	LTE	LTE	LTE?	- Networked radio that meets approved standard - Protected Aeronautical Spectrum?	- Networked radio that meets approved standard - Protected Aeronautical Spectrum?	- Networked radio that meets approved standard - Protected Aeronautical Spectrum?

UAS Use Cases and Assumptions- Consensus Priorities

UAS Mission Type-->	Operations Over People (Public Events)	Rural, Contained Area Operations	Rural, Linear Operations	Suburban/Urban (Dynamic Operations)	Small Cargo (Networked Operations)	Medium Cargo	Large Cargo	HALE
BVLOS	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rule Implementation	Part 107 Waiver	Part 107 Waiver	Part 107 Waiver	Part 107 Waiver	Part 135	Part 135	Part 135	Part 91
All manned aircraft required to broadcast position	N/A	No	No	Yes	Yes	Yes	Yes	Yes at altitude, No during climb
Manned Traffic Density	None	Low	Low	Medium	Medium	Medium	High	Low altitude at altitude
Altitude	< 400 ft	< 400 ft	< 400 ft	< 400 ft	< 400 ft	< 10,000 ft	Class A	> FL600
Weight	< 55 lb	< 55 lb	< 55 lb	< 55 lb	< 55 lb	> 500 lb	> 12,500 lb	> 55 lb
Multiple UAS per pilot	Depends on operation	Depends on operation	Depends on operation	Depends on operation	Yes	No	No	No
Typical Applications	- News gathering parades; stadium events; media coverage; music festivals	- Agricultural Sensing - Bridge inspection, Agricultural mapping; Wildlife observation; Surveying/ inspection	Pipe inspection; advertising over water front; Railway inspection; hiking trail	S&R, News gathering (long distance)	- Package delivery	- Humanitarian Delivery of critical supplies	- Traditional cargo	Comm relay
Industry Need within 24 months	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low
Ease of Implementation within 24 months	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low
Safety Risk	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low	High/Medium/Low

Drone Advisory Committee – Special Committee
Task Group 2: Access to Airspace
Focus Group 1: sUAS BVLOS in the Mode C Veil (DAC SC TG2 FG1)

Introduction

Providing safe Integration to the United States (US) National Airspace System (NAS) for Unmanned Aircraft System (UAS) is an extremely complex endeavor. The Drone Advisory Committee (DAC) was established to develop recommendations to the FAA to enable the integration of UAS into the NAS. TG2 was tasked to identify recommendations for near-term (24 months) increased airspace access for small UAS (sUAS). TG2 considered a number of sUAS use cases based on the three criteria of sUAS industry demand, safety risk, and difficulty of implementation. A key consideration to enabling UAS access is the small UAS rule that became effective on August 29th, 2016. The small UAS (sUAS) rule, Part 107 of Title 14 of the Code of Federal Regulations (CFR) (14 CFR 107), currently regulates UAS weighing less than 55 pounds (sUAS), e.g. to operate during daylight hours within visual line of sight of the remote pilot and not over people. It also provides for unmanned aircraft to operate beyond these restrictions via waiver[1]. 14 CFR 107 does not permit, even by waiver, "the carriage of property of another by aircraft for compensation or hire"; TG2 was informed that the FAA believes the current approval path for these types of "small cargo" operations is under 14 CFR 135 because they are considered air carrier operations. TG2 does not believe new UAS regulations are likely to be published in the near future and thus will focus on solutions that allow operations within the current regulatory framework of Part 107 and Part 135.

TG2 understands the UAS community is primarily focused on using sUAS for operations at low altitudes. After discussion of various UAS use cases, the need to enable operations beyond visual line of sight (BVLOS) was deemed high priority for the UAS industry. Three key challenges face sUAS operating BVLOS: (1) communications between the UA and the remote control station/pilot, (2) separation assurance from other aircraft and hazards and (3) navigation performance. These are often described in the UAS research community as (1) control and non-payload communications (CNPC), (2) detect and avoid (DAA), and (3) containment or geofencing.

FG 2 will be discussing CNPC and communications overall as well as other equipage requirements including navigation/geofencing and DAA requirements. FG 1 is describing a recommendation on which airspace the FAA should focus it's near term efforts and thus is an input to these other focus groups.

Scope

1. Mode C veil[2]
2. Below 400 feet
3. sUAS

[1] 14 CFR 107 Subpart D—Waivers
[2] AIM 3−2−3 (6) Mode C Veil

Assumptions

1. Allow for routine normalized operations
2. A methodology accepted by the FAA administrator as a means to fly BVLOS safely
   a. Flight over people
   b. Detect and avoid other aircraft (including UAS)
   c. Avoiding other hazards

Recommendation

> **FG1 recommends that in the near-term, FAA focus on sUAS BVLOS operations within the Mode C veil below 400 ft AGL.**

The Mode C Veil consists of airspace within 30 nautical miles of the 37 principal class B airports.

TG2 understands that the FAA has a program called Low Altitude Authorization Notification capability (LAANC) to expedite the approval of sUAS under Part 107[3] to operate in Class B, C, D or within the lateral boundaries of the surface area of Class E airspace. This program is based on facility maps around these airports, designating areas that are controlled airspace but have been designated as being acceptable for limited sUAS activity. In particular, areas that are currently controlled airspace below 400 feet AGL but are also below the obstacle clearance surfaces (OCS) for either the airport itself or any instrument approach at the airport could be considered for sUAS operations.

Rationale (Pros)

One significant safety concern for UAS operations BVLOS is collision with a manned aircraft. Therefore, either: (a) the UAS must have an approved DAA system, or (b) the airspace must be segregated between manned and unmanned operations. Therefore, the only practical solution for the Mode C veil, high demand, airspace is the sUAS have a DAA system. Detection of non-cooperative aircraft is a challenging problem that various research and standards groups have worked for more than a decade. While there DAA solutions under development, as of this writing there are currently no methods to detect manned non-cooperative aircraft that are ready for deployment on a sUAS. Within the Mode C Veil, IAW 14 CFR 91.215, all aircraft will be equipped with, at least, a Mode C transponder, thus making it an easier first step. By January 1st, 2020 the vast majority of manned aircraft operating within 30 NM of one of the primary class B airports will be required to broadcast their position and velocity via automatic dependent surveillance broadcast (ADS-B)[4]. These areas are also generally the areas with the most comprehensive air traffic services and ground-based surveillance coverage. This coverage will improve with the full implementation of ADS-B and the FAA's SBS could be leveraged for providing this information to sUAS

[3] 107.41 Operation in certain airspace.
[4] 91.225 Automatic Dependent Surveillance-Broadcast (ADS-B) Out equipment

operations. sUAS operators can use the position information of the manned traffic to remain well clear of those aircraft.

Due to their size and weight limitations, most sUAS have quite limited range/endurance. They must be operated close to their mission area. Based on 2010 Census data, approximately 176 million people or 56% of the U.S. population live and work in metro areas inside the Mode C Veils. These metro areas represent a large customer base living in high density areas for the UAS industry. These areas afford numerous opportunities to serve the public beyond package delivery. Before any BVLOS operations can be authorized for routine use, the FAA must publish criteria for flight over people; without that criteria, in the opinion of TG2, normalized operations of BVLOS is not practical in Mode C Veil airspace.

This recommendation allows for the use of existing 14 CFR 107 and 14 CFR 135 regulations to get near term access to airspace for the UAS industry.

Challenges (Cons)

UAS Operating in urban and suburban areas involves flying over human beings. Identifying a combination of acceptable safety mitigations for operating over people has been a difficult challenge. Clearly, for UAS to operate effectively in these urban and suburban areas, an acceptable combination of aircraft reliability, performance and other safety mitigations must be found to allow for operations over human beings.

While the Mode C Veil requires most manned aircraft to equip with a transponder (and by 2020 with ADS-B, there are exceptions. The requirements for transponder and ADS-B equipage “do not apply to any aircraft that was not originally certificated with an electrical system, or that has not subsequently been certified with such a system installed, including balloons and gliders.” Although few gliders and balloons operate in these urban and suburban areas, this does present a challenge to the assumption that the UAS operator can detect 100% of the air traffic via transponder and ADS-B. It is worth the effort to investigate other means to mitigate the risk of collision with the limited number of these unusual manned aircraft.

Navigation performance of all aircraft (including sUAS) is critical to the safe operations in the NAS. If the FAA follows these recommendations allowing sUAS to operate in the general vicinity of these large airports, the navigation system onboard the sUAS must have integrity. The sUAS must be able to establish acceptable performance of the navigation sensors, the flight technical error, and navigation database assurance. sUAS are subject to the same performance based operations (PBO) standards as manned aircraft for the appropriate class of airspace.

Drone Advisory Committee – Special Committee – DACSC
Task Group 2: Focus Group 2: Equipage Focus Group

Issue Description

As part of the guidance provided by FAA through the Drone Advisory Committee (DAC), Task Group 2 (TG2) of the Drone Advisory Committee Subcommittee (DACSC) was tasked to develop recommendations to the FAA that will facilitate increased near-term (within 24 months) airspace access for UAS into the NAS. TG2 considered several UAS use cases based on industry need, ease of implementation, and safety risk. Consensus was reached by TG2 to focus on low altitude (less than 400 feet) BVLOS operations for two use cases: dynamic suburban/urban operations that require waivers to or permissions beyond those currently provided for under part 107 of the FAR's, and BVLOS networked operations such as small cargo operations.

The equipage focus group was tasked to provide recommendations on the necessary UAS equipage for those operations. We believe that UAS systems used for BVLOS require navigation, information sharing, collaborative detect and avoid, and communications features.

Navigation: Precise navigational performance is required to safely integrate into the NAS. This includes compliance with geo-restrictions, and minimum UTM performance requirements relative to the type of airspace being accessed,

Information Sharing and Collaborative detect and avoid: The scenarios described above are expected to be in higher density areas and in airspace where operational requirements will generally dictate that most aircraft be suitably equipped. Systems must be able to provide a level of separation assurance suitable to the airspace in which they operate. Examples of such technology which could be considered are ADS-B, and V2V collision avoidance systems similar to those being incorporated in the automotive industry.

Communication. There is a separate focus group regarding CNPC (Command and Non-Payload Communication), so the equipage group did not address any required communication equipage.

Influencing Factors

UAS equipage is not a one technology solution. For example, Unmanned Aircraft (UA) utilize a broad range of aids and sensors in navigation such as GPS, visual navigation, ground based navigational aids, ultrasonic sensors, LTE positioning based on ranging signals with "observed time difference of arrival", and many others.

Industry innovation in technologies. Technology is rapidly evolving with new technologies becoming the baseline in consumer and commercial drones providing improvements that would not have been considered feasible just a few years ago. Any approach for performance-based requirements needs to enable innovation and incorporation of new technologies. For example, there have been advances in mobile devices including fusing GPS and global navigation satellite services (GNSS) with GPS augmentation, LTE base station ranging data, and on-device inertial sensors that have resulted in improved mobile position accuracy. Such advances can also be used in unmanned aircraft today.

Support existing operations. Existing Part 107 operations consist of a wide range of aircraft from self-built to large scale manufactured aircraft. Providing a framework that enables the range of operations is important. Manually piloted options in VLOS may not require navigation performance beyond the ability of the pilot to ensure the vehicle remains in a specific fixed location, whereas other use cases such as BVLOS would require the use of some form of ID, navigation and tracking technologies.

Approach

The approach focuses on performance-based standards for operations instead of prescribed specific technologies. Performance-based standards are technology agnostic, enabling industry to continue to innovate and iterate current technologies to improve equipment. Prescribing a set of current technologies could limit industry innovation, increase the cost of aircraft without an improvement in safety, and negatively impact current operations.

For a performance-based standard to be effective, it should also consider the type of operation, phase of flight and operating conditions.

Current Part 107 operations vary widely. We recommend that increased equipage and performance should enable additional airspace access, higher density route planning, and more complex operations such as BVLOS.

Initial Recommendations

1. Enable integrated BVLOS airspace by sharing intent, position data information, and other information that helps operators maintain awareness of other aircraft in the Mode C Veil. Sharing of information should consider navigation performance. This collaborative airspace, involving manned and unmanned aircraft, should incorporate information technology neutral, performance-based requirements.
2. Evaluate and establish performance-based navigation requirements for BVLOS operations in Mode C Veil.

Focusing on technology agnostic, performance-based equipage enables industry to continue to innovate and improve safety while identifying key ways to integrate with the NAS, geo restrictions and collaborative airspace.

DAC SC – TASK GROUP 2

Focus Group 3 - CNPC

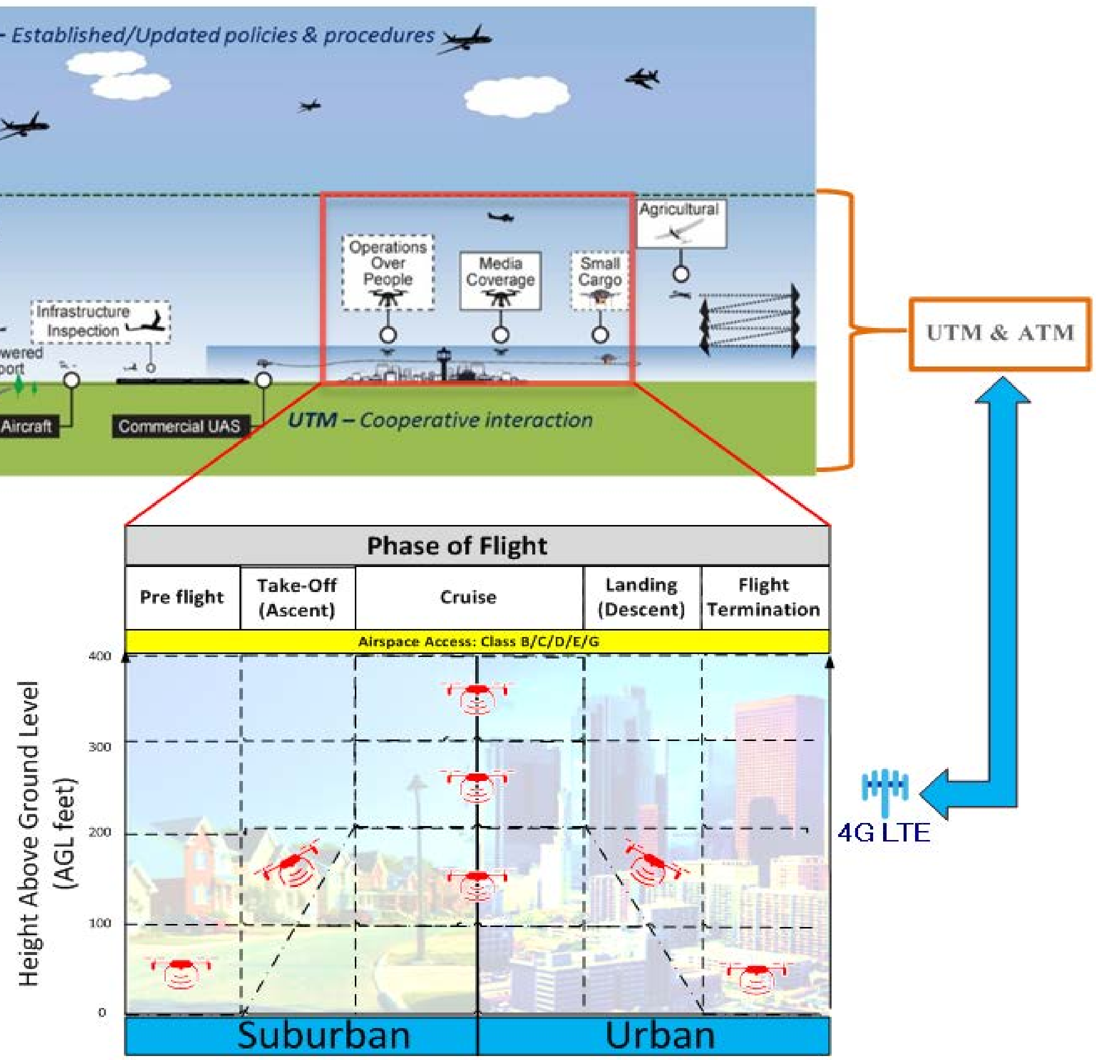
Task: Provide recommendations on methods of communications for command and non-payload communications (CNPC) for UAS operating beyond visual line of sight (BVLOS) in urban and suburban environments at 400 ft. AGL and below

Note: CNPC is used as a general term for describing the connectivity for UAS at 400ft. AGL and below and not intended to align with the definition used in RTCA SC-228

1. Statement of Issue

A UAS operating beyond visual line of sight (BVLOS) in urban and suburban environments at 400 ft. (AGL) and below must have options for connection to a reliable, secure, and cost-effective wireless network that can provide connectivity for data exchange when such connection is required across all phases of flight. This connectivity will provide traffic management systems (UTM and ATM) the ability to provide a centralized management of airspace safety.TG2 identified cellular (LTE) as an option for connectivity that would benefit from a focus group review (FG-3) while recognizing that other UAS connectivity options are being assessed by organizations such are RTCA SC-228 e.g. Satellite. This FG-3 issue paper is intended to examine the viability of the existing commercial cellular network (e.g. 3G, 4G LTE) in providing connectivity for command and non-payload communications (CNPC). The
Use case operation and environment under review is presented in **Figure 1-1.**

Figure 1-1 Overview of Use Case Environment



It should be noted that CNPC is supported through a wide range of connectivity options today (including hybrid models) based on the use case of the operations. This includes:

- Point to Point Command and Control e.g. 2.4 GHz receivers.
  - Commonly used for VLOS, and has range for EVLOS operations and beyond with repeaters
  - Ground control stations may or may not have additional internet connectivity. Commonly available UAS systems utilize an operator phone and/on tablet as the operational display.
  - Point to point cases tend to have the pilot in either direct control (at the sticks) or requires connectivity to make necessary in flight adjustments. Overall a lower level of autonomy.
- IP Based Command and Control e.g. UAS connecting directly to the internet (LTE, WIFI, etc.)
  - Used for VLOS, EVLOS, and BVLOS,

- Assumed internet connectivity and data may be sent to operators over multiple networks, or multiple means of connectivity.
- Utilized by systems that are more latency and loss link tolerant e.g. the vehicle has increase autonomy and may not rely on connectivity to handle many in flight adjustments. For example, loss of LTE connectivity in a backyard during delivery can still result in a safe operation.

This document does not examine other existing or developing connectivity options. The intent of this paper is to assess the viability of the existing commercial cellular networks for the BVLOS operations in suburban and urban environments at or below 400ft AGL.

2. Course of Action

The course of actions described below are already being aggressively pursued across the globe through private, standards, industry, and regulator driven initiatives. The following are examples of industry and standard group interest in UAS (drones):

- 3GPP Study on enhanced Support for Aerial Vehicles
- GSMA Drones Interest Group
- ATIS Unmanned Aerial Vehicles Group
- ASTM F38
- RTCA SC-228
- CTA (R06 WG23 Unmanned Aerial Systems)
- CTIA UAS Spectrum Working Group

Course of Action:

1. Characterize the network performance in rural, urban, and suburban environments providing connectivity to UAS 400 ft. and below and define a minimum performance specification that can support an operator’s concept of operations for safe UAS operations in NAS. This requires an understanding of the network performance variance observed across multiple specific instances of each operating environment type.
2. Recommend that communication requirements fully consider the operator’s concept of operations.
3. Explore roadmap for Vehicle to Vehicle communications and avoidance including LTE/5G and 802.11p
4. Explore the advantages and disadvantages of deploying additional dedicated UAS/aviation spectrum to augment existing commercial licensed bands for this use.

5. Explore unlicensed/shared band LTE deployments for UAS, use redundant links and bands, local versus wide-area access.
6. Outline UAS roadmap for cellular connectivity: 4G to 5G evolution

3. Influencing Factors

Key factors influencing recommendation for leveraging LTE networks for CNPC:

1. Many BVLOS and Urban/Suburban operations will occur within areas with high LTE coverage
2. Operational requirement for communications vary per use case including which phases of flight require coverage, latency, etc.
3. Timing: Cellular LTE networks are deployed today and operating with high level of reliability and security
4. LTE is based on 3GPP world standard
5. Multimode/multiband chipsets for cellular devices support connectivity options over 2G/3G/4G networks as well as other radio technologies such as Wi-Fi.
6. LTE UAS link performance in terms of latency, reliability, coverage, data rate, UAS density, positioning accuracy, etc. being demonstrated and validated through field trials and simulation
7. UAS device volume and bandwidth need is low compared to capacity of LTE networks
8. LTE services could also be used for UAS payload communications (e.g., sensor control, sensor data downlink). Using the same technology for CNPC and non-CNPC UAS communications could provide cost savings.
9. Cost of entry is low for connectivity and equipment (~$15 LTE Cat 1 Module) given leverage from the massive scale of cellular
10. UAS equipage for LTE + other radio connectivity (2G, 3G, Wi-Fi) is extremely low in weight (4-10g on average, not including battery or antenna(s))
11. Ability to uniquely identify each UAS
12. Ability to handle redundant communication paths e.g. SMS plus data, or two concurrent data sessions with different APNs (Access Point Names). Can also utilize multiple providers to improve coverage.
13. Provides latest evolution for spectrally efficient simultaneous service to multiple devices

Several of these key factors are supported by quality data coming from controlled trials being conducted by many companies. It should be noted that the LTE connectivity performance needs to be considered within the context of system level requirements and is expected to be assessed within an overall risk profile for the given use cases and operational scenarios.

Considerations for Risk Assessment

Security: Security has been a required feature in commercial mobile networks since the digital revolution for ensuring authorized access to service, to protect user communications from eavesdropping, and to prevent unauthorized access to the network infrastructure that could result in service outage. Security protocols involve user/device authentication, key generation, exchange and management, mutual authentication, encryption, and decryption. The security mechanisms developed and adopted in the wireless network standards bodies have benefitted from intense scrutiny by wireless professionals as well as by security experts in industry and academia. UAS systems may add additional layers of security regardless of communication protocols e.g. certifications, encryption, and additional authentication and authorization.

Lost Link: At system level, the link performance needs to be assessed in combination with the UAS autonomous technology (equipage) to determine risk. Cellular performance + autonomous capability = low risk to safety from temporal lost link events. The relevant metric for network performance is "availability" (ability to establish a connection when and where required) not "link loss".

Network Coverage/Reliability: Cellular networks in the US are engineered for massive volumes and cover more than 99% of Americans at approx. 300 million people. 56% of US population resides inside mode C veil. High risk areas are populated and located in proximity to transport infrastructure (e.g. airports). Cellular networks are designed to serve these populated areas with high capacity and high reliability/coverage. There is a strong correlation between high risk airspace environments (controlled from surface) and high risk populated areas with quality of the cellular network.

Rural areas are also well served by cellular coverage, when also considering 2G and 3G services, with UAS benefiting even more from the free space propagation in areas with low blockage such that multiple base stations can be detected by UAS at long distances. UAS, at a distance and at height, can be in the main beam of a cellular base station antenna and can be served by proximity base stations or by base stations > 10 miles away (observed in actual field testing). Rural areas have low blockage in majority of locations (hilly and mountainous regions have challenges) so combined with free space propagation characteristics up to 400 ft. enables high network connection availability. UAS flight paths in rural areas where there are highways and cross country roads are supported by cellular networks deployed to serve the automotive traffic.

Network Capacity: Cellular network capacity has increased to meet the incredible growth in demand. One carrier reported that data traffic grew more than 150,000% between 2007 and 2015 (note: data usage per user very low in 2007)

Protected Spectrum: Cellular networks use licensed spectrum protected under FCC regulations. The operators/carriers purchased this spectrum at a significant cost (billions of $) and implement several metrics (Key Performance Indicators: KPI's) to monitor the use of their spectrum to ensure high-quality service. In the US, there are multiple frequency bands allocated and owned by large operators/carriers such that the networks utilize several bands within any given market. This effectively results in low probability for "jamming" as the user device or UAS has more than one frequency band to use. This is particularly true for an inflight UAS that is receiving from multiple ground base stations over multiple frequency bands. 5G has been allocated new frequency bands which means that the frequency options for user devices and UAS will continue to increase. Carriers have experience in migrating to newer technology. With the introduction of 5G and additional spectrum resources, the frequency options for user devices and UAS will continue to increase.

QoS – Quality of Service: The term used for the techniques that enable differentiated service level for different users, channels, and/or applications. Not only can messages be prioritized, but channels (called "bearers" in LTE) can be established depending on the latency requirements for the application. QoS mechanisms allow the network to be informed of the application quality requirements, and to adjust data delivery methods to achieve those requirements. For UAS, QoS capabilities can be used to manage different priorities for connections. As an example, a UAS that requires assistance from a ground operator to perform a safety maneuver has a higher priority than a UAS that has already landed. QoS features enable the network to adjust service quality based on dynamic connection priorities to enhance the overall safety of the UAS.

Broadcast and Device-to-Device Features: Advanced features that are being incorporated into standards at present, and could be available in the next few years are LTE Broadcast and LTE-Direct. LTE Broadcast (also called eMBMS for evolved Multimedia Broadcast Multicast Service) can be used for distributing common content to multiple terminals simultaneously. For example, alert/warning/command messages can be sent to a whole fleet or a subset of a fleet quickly and efficiently. LTE-Direct (also called LTE-D) is a technology that supports direct discovery between two devices and ultimately direct communication as well. For UAS, such a direct connection could facilitate high-reliability, low-latency data transfer between nearby UAS enabling collaborative tasks or for collision detection and avoidance.

4. Discussion

Introduction

UAS commercial applications are growing rapidly with some applications now requiring beyond visual line of sight capability (BVLOS), operations over people, and night operations transitioning different environments (rural to urban to suburban) and airspace classes (e.g. Class G to Class B). Like air traffic management and control today, wide-scale deployments of UAS require coordination and traffic management. This will be needed, especially for large fleets of autonomous UAS flying in or near controlled air space (e.g., an airport or military air base).

To perform this management, the UAS must have equipage and a supporting network that allows for connectivity between the UAS and the operator, and the operator to the management system (UTM and ATM when required). LTE commercial networks and LTE-equipped UAS are well positioned to serve this need. Today, there are multiple field trials going on around the globe to evaluate and validate this capability.

Cellular technology (4G LTE and 5G) can bring a new dimension of high reliability, robust security, ubiquitous coverage, and seamless mobility to wide-scale UAS operation. Cellular networks facilitate the operation and control of UAS beyond a pilot's visual line of sight, which will be key to safe, wide-scale UAS operation and the many new services to which UAS open the door. Furthermore, cellular connectivity can enhance autonomous UAS operation safely by enabling and expediting the delivery of optimal flight plans and transmission of flight clearances, tracking UAS location and adjusting flight routes in near real-time.

It is a fact that today's cellular networks are designed to serve smartphones and other ground mobile devices however the actual LTE network deployments result in an RF profile that extends to the low altitudes currently defined for small UAS. Testing by multiple organizations has resulted in consistent finding that UAS are very well-served by the networks even compared to the devices on the ground. In fact, the signals observed by UAS at altitude are significantly more benign than those observed by devices on the ground where clutter, multipath, and blockages are more severe. These line-of-sight conditions for UAS have been shown to produce signals that have smaller variations in power between different locations in the network, and smaller short-term dynamics during UAS flight, simplifying both signal tracking and handover operations while in motion. Various operators utilize cell based communications to manage their operations today.

As the commercial UAS traffic increases, there are opportunities to optimize the LTE networks to better balance the service between ground-based and airborne network users. To deliver optimized performance, it is important for the network to be able to distinguish a UAS from a ground mobile device, e.g. during SIM card registration/user agreements.
The effectiveness of the UAS Traffic Management (UTM) system will depend on scalable communications network(s) to enable new capabilities, such as accurate and reliable UAS tracking, two-way data communications between UAS <-> Operator <-> UTM/ATM, and access to near real-time information for flight-planning, flight authorization, flight reroutes and no-fly zones/emergencies.

Evolution of Network Reliability

Cellular networks have evolved through the different generations to now a 4th generation LTE network that is an order of magnitude more reliable than the previous generation. This is particularly true for the outdoor users. This trend will continue with 5G as a next step in that evolution with a resulting improvement in UAS connectivity performance for more mission critical applications.

Evolution of Mobile Network Technology

To keep pace with demand, the process of developing enhancements to mobile technologies and implementing those technologies in mobile networks continues at a rapid pace. Today, many new technologies are in the pipeline, and here we focus on two primary categories: link enhancements, small-cell deployments and discuss their relevance to UAS.

Link Enhancements

Larger amounts of spectrum are being allocated for commercial mobile networks. New technologies and standards are currently under development to further optimize the use of this spectrum.

First, interference cancellation techniques help receivers to not only reduce noise from neighboring users' transmissions but effectively estimate and erase them from the incoming signal before demodulation.

Second, enhanced multi-antenna methods such as MIMO and beamforming are being designed for use in wide-bandwidth channels that can enable effectively "pointing" of the signals to increase the intended user SNR while reducing interference to other spatially separated users. A new aspect of this optimization is being designed that enables dynamic coordination between base stations as the users they serve move in the network.

Finally, because available spectrum is sometimes in non-contiguous blocks, techniques that allow the aggregation of spectrum in different bands into a single effective channel can significantly increase peak data capacity and speeds. This technique is known as "carrier aggregation". It allows wireless operators to bond spectrum in different bands to create channels that are up to 100 MHz-wide, leading to very high average and peak data rates. Currently, devices already support 40 MHz aggregation in the downlink (i.e. base-to-mobile) and further increases are planned over the next two years including uplink carrier aggregation i.e. link bandwidth from the UAS to ground network/services.

Link enhancements create benefits for all uses (throughput per device, number of devices supported, coverage, etc.). But because signals from ground-air and air-ground propagate further than ground-ground signals, interference can be larger for aviation use relative to terrestrial use. Thus, interference management from cancellation and spatial processing is expected to be particularly beneficial for UAS.

Small-Cell Deployments

Traditional high power base stations deployed on towers called "macro cells" have a coverage area of several kilometers. However, macro cells can be augmented with deployment of so-called small cells, which use much less power and do not need to be deployed on a tower. These small cells include so-called femto cells and pico cells. Small cells cost much less than macro cells and because they do not need to be deployed on towers, they are not as limited by zoning laws.

Another goal for small cells is to facilitate local coverage improvement by enabling simple deployment and activation of a small base station or set of small base stations. These would automatically integrate into the larger wireless network or in an isolated area and could simply provide local wireless connectivity to the wired network (on a remote farm, for example). This would enable a UAS to operate in these locations using the same radios and protocols as existing cellular networks use today.

For UAS, the ability to deploy small-cells easily to enhance coverage and capacity will enable safety and performance improvements in selected geographical areas. Examples include takeoff and landing locations such as delivery distribution hubs, corporate shipping and receiving sites, and battery charging/swap stations, areas of high UAS density including urban environments, and specific mission-focus areas. These small-cell deployments could be semi-permanent, or could be temporary depending on mission needs.

UAS CNPC Link Assessment:

1. Types of data from UAS to Operator:
   - Telemetry updates (configurable from 1 update/second to 1 update/minute)
   - Health of aircraft (asynchronous events, battery life, maintenance alerts)
   - Payload status
   - Health of Communications Channel(s)
   - UAS traffic management system data
   - Sense-and-avoid data
2. Types of data from Operator to the UAS:
   - Flight path adjustments (weather, TFR's, Operator driven changes, etc.)
     - Remote operation and take over
   - Mission instructions
   - Approval for flight route prior to initiating flight

5. Recommendations

The following recommendations should be pursued to validate the use of the existing cellular network (2G/3G/4G LTE) as an option in providing CNPC connectivity for safe operation of UAS for low-altitude applications:

a. The FAA sponsor a program to evaluate the viability of leveraging the existing cellular network as a connectivity option in the context of performance based C2 and concepts of operation. The FAA should consider leveraging the 3GPP work study item (Study on Enhanced Support for Aerial) as an input to this program (e.g. a Minimum Aviation System Performance Standards - ***MASPS***)

b. The FAA sponsor an operational prototype that includes cellular connectivity, via the existing commercial cellular networks, as a C2 option. Within this prototype the FAA should pursue the opportunity to pull cellular connectivity data directly from other industry trials.

Drone Advisory Committee – Special Committee – DACSC

Task Group 2: Focus Group 4: BVLOS Commercial Ops Focus Group

Issue Description

Task Group 2 (TG2) of the Drone Advisory Committee Subcommittee (DACSC) was tasked to develop recommendations to the Federal Aviation Administration (FAA) that will facilitate increased near-term (within 24 months) airspace access for UAS into the National Airspace System (NAS). TG2 reviewed and prioritized a number of UAS use cases based on industry need, ease of implementation, and safety risk. Consensus was reached to focus on low altitude (less than 400 feet) BVLOS operations associated with dynamic suburban/urban operations that require waivers to or permissions beyond those currently provided for under Part 107 of the Federal Aviation Regulations (FARs), and BVLOS Part 135 delivery operations. These were chosen because they are beyond operations currently authorized, and they meet a significant portion of emerging market needs. Focus Group 4 was tasked to provide recommendations on what would be needed from an operating certificate, licensing and airworthiness standpoint to enable networked BVLOS commercial delivery operations.

Influencing Factors

The FAA, in their Aerospace Forecast 2017-37, predicts the commercial small UAS fleet in the United States will exceed 420,000 by 2021, compared to 42,000 in 2016. While there clearly is a pressing demand to determine how to safely accommodate this order of magnitude increase in commercial operations, the pathway is anything but clear. Given the two year scope for our activities, and the very challenging legislative and regulatory environment, we must evaluate all recommendations against the practicality and feasibility of seeking legislative outcomes and/or rulemaking to enable expanded UAS operations. The most pragmatic solution is to focus first on ways to work within the framework of existing rules- mindful of the fact that this activity could very well point to the need for a long term UAS specific solution achieved via new rulemaking.

14 CFR Part 107 "Small Unmanned Systems" specifically disallows waivers to visual line of sight aircraft operation if those operations allow the carriage of property of another by aircraft for compensation or hire. In discussions with FAA, when seeking initial guidance regarding under what operating framework UAS operators will be able to perform BVLOS delivery operations for compensation or hire (barring exemptions to the rule), TG2 was instructed that the most practical way to achieve this for vehicles of any mass- to include those less than 55 pounds in the near term would be to review current guidance found under 14 CFR Part 135 - "Operating Requirements: Commuter and on Demand Operations and Rules Governing Persons on Board such Aircraft," Part 119 - "Certification: Air Carriers and Commercial Operators," and other portions of the FAR's to include pertinent areas of Part 91 under general operating rules. Under this framework, applicants would be required to work categorically through the rule, submit an application to be certified to conduct commercial operations under Part 135 in the case of on demand operations for compensation or hire, and establish an underlying airworthiness basis and licensing requirements that support the terms and conditions of the operating certificate.

Based on this initial guidance we next consulted with the FAA UAS Integration Office and received briefings on airspace classifications and operations from ATO and an overview of the requirements to conduct on demand operations and common carriage operations from the FAA Air Transportation Division's Part 135 Air Carrier Operations Branch (AFS-250). The input from both of these entities within FAA backed up their recommendation that the most viable path forward to enable networked cargo operations would be to perform a thorough analysis of those sections of Part 135 (and other sections of the code) pertinent to operations, and simply begin working through them. Regarding vehicle weights, it should be noted that the focus of this activity was not restricted solely to small UAS, because while Part 107 is currently restricted to vehicles under 55 pounds, no such limitation exists under Part 135.

Approach

Our work is anchored in the need to remain allegiant to the scope of our mandate - namely, referencing the certification pathway for low altitude networked BVLOS operations for compensation or hire as the desired output, and defining realistic and achievable inputs to move towards that goal. A comprehensive review of 14 CFR Part 135 is essential to develop a greater understanding of what subparts would be applicable to networked UAS operations (e.g. Subpart B - Flight Operations), and which would not (e.g. Subpart L - Helicopter Air Ambulance Operations). In reality, the analysis may need to be even more granular. It needs to be which provisions apply, and which do not. In some cases, an entire subpart will apply or not. But, in other subparts, some provisions may be applicable, while others are not. It should also be noted that Part 135 contains by reference other portions of the FARs (for instance Part 119 for pilot qualifications and Part 91 for weather limitations).

Just as Part 107 explicitly lists which portion of the rule are subject to waivers, it is important to also understand which portions of the FAR's impacting UAS applicants' ability to gain operating approvals under the applicable FAR's would be subject to waiver, exemption, deviation, and alternate means of compliance. For instance, would it be feasible that portions of Part 107 could be used to satisfy the requirements for portions of Part 91 or Part 135? Will pilot licensing requirements associated with commercial operations in higher altitude blocks in controlled airspace be required for highly automated commercial BVLOS operations below 400 feet, or will an alternate means of compliance proportionate to the risk profile suffice? It should also be explored how upcoming performance based vehicle certification rules such as the Part 23 rulemaking change will impact applicants' ability to meet design and performance requirements. Will this facilitate a new "permit to fly" airworthiness concept for certain BVLOS operations?

Finally, we should be very realistic with regard to the timelines. The work should be incremental and multi-phased, beginning with a review of those regulations most critical to BVLOS commercial operations (e.g. Part 135), then defining the process by which UAS operations could be approved and, finally, developing a detailed roadmap, for the benefit of applicants, of what would need to be accomplished under current FARs.

We focused on BVLOS below 400 feet as operating in that altitude block mitigates for many airborne risks-especially when those operations are conducted in the Mode C veil, and understanding and establishing associated risk controls affiliated with these operations facilitates many expanded Part 107 and Part 135 use cases. By placing a particular focus on Part 135 operations, TG2 felt this also solves for many requirements associated with airworthiness, licensing and operational approvals associated with a broad variety of use cases.

Initial Draft Recommendations

1. FAA UAS Integration, Flight Standards and other applicable offices shall provide strategic overview and ongoing updates regarding what they believe are the most effective and timely pathways to enable commercial UAS operations, by category of operations, primarily in a low altitude BVLOS environment. This should include a review of studies and work performed to date.

2. FAA shall prioritize a “Pathfinder” style Part 135 certification research and implementation program to thoroughly review all rules, orders, and Operation Specifications related to UAS operators’ ability to obtain commercial permissions for low altitude BVLOS operations for compensation or hire. This should result in a performance based commercial operating certification pathway, derivative of current rules, that that is UAS specific and will facilitate operations below 400 feet (although conditions and limitations associated with each operating certificates defines specific operational limits).

3. FAA shall create a template based on current rules that explains this process path. It should address all applicable rules, airworthiness requirements and the means of conformance for UAS applicants seeking to conduct BVLOS commercial (to include on demand/common carriage) operations. This template could take the form of an Advisory Circular or other guidance that benefits new applicants.

The FAA’s 2017 Implementation Plan for Integration of Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS) states that over the next year (2017) it will develop a plan for ultimately enabling small cargo UAS door to-door package delivery and UAS passenger operations, and that this plan is expected to consider issues such as design and airworthiness requirements and equipment necessary to safely implement operational concepts.

In light of near term (within five year) ten-fold commercial UAS growth projections, in order to ensure the safe integration of commercial UAS operations into the NAS we need to first understand the relationship between current requirements and the unique attributes of UAS, next define first steps towards enabling commercial BVLOS operations juxtaposed against current certification requirements, and finally, using Part 135 operations as a representative example, clearly define this process path. The draft recommendations are the first steps in providing pragmatic solutions to safely meeting industry needs in the near term, and defining more permanent solutions over the longer timeframe.

Drone Advisory Committee – Special Committee – DACSC
Task Group 2: Focus Group 5: (DACSC TG2 FG5)
Recommendations for Actions Beyond the 24 Month Timeframe

Introduction

Providing safe access to the United States (US) National Airspace System (NAS) for Unmanned Aircraft System (UAS) is an extremely complex endeavor. The Drone Advisory Committee (DAC) was established to develop recommendations to the FAA to enable the integration of UAS into the NAS. TG2 was tasked to identify recommendations for near-term (24 months) increased airspace access for UAS. TG2 considered a number of UAS use cases based on the three criteria of UAS industry demand, operational risk, and difficulty of implementation. The Committee was also tasked to provide additional recommendations on expanded access for UAS operations/missions that may require public/private infrastructure, rulemaking, and/or other changes that would extend implementation beyond the 24 month timeframe.

Scope

Continued growth and full integration of UAS into the NAS will provide significant economic, societal, and environmental benefits. While the workgroup tasking within the 24 month timeframe will provide significant building blocks in achieving integration, we must continue to identify necessary steps to achieve full integration. Many elements of the current aviation system (infrastructure, procedures, policies, etc.) may need to be modified to support the wide range of new capabilities. This full integration must actively be pursued without undue burden on current airspace users and service providers, and without compromising safety.

Assumptions

The ability to operate UAS Beyond Visual Line of Sight (BVLOS) above 400 ft AGL is required to accommodate the future growth of the industry.

The regulatory change process is slow and requires initiating necessary changes now to keep pace with industry demands.

We are encouraged that the Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration (NASA) are fully committed to the development and deployment of UAS Traffic Management (UTM) as currently defined. Introduction of UTM increases likelihood of some level of air traffic control/traffic management of all air assets operating in the UTM airspace strata. For Visual Flight Rules (VFR) operations, UTM can be used to coordinate and control users that are part of the system, but do not necessarily need to interact with all other airspace users if each UTM participant has some onboard capabilities.

The FAA has informed the DAC that it intends to establish the Controlled Airspace ARC, which will work towards the integration of UAS into Controlled Airspace under Instrument Flight Rules (IFR). Therefore, the DACSC assumes that this set of UAS use cases for BVLOS operations under IFR are already in the process of being enabled.

The Goal

The goal is a set of operational rules that provide the flexibility of operations under VFR but while flying by reference to displays and instruments without natural visual reference. The existing set of IFR rules is most likely not well suited to handle dynamic operations of UAS conducting aerial work on a routine basis. In practice, we appreciate the need for regulations similar to those currently categorized under IFR, especially Communication, Navigation, and Surveillance (CNS) equipage and obstacle/terrain clearance. Recent work on operational environments and use cases conducted by MITRE and shared with the DACSC acknowledge this gap in the regulatory regime, which is exposed by UAS but may not, eventually, be applicable to airspace users beyond UAS. It is widely recognized that the technology that would fully enable this operational goal for UAS has yet to be fully developed.

The UAS Industry requires access to airspace above 400ft AGL for BVLOS operations in both Radio Line of Sight (RLOS) and Beyond Radio Line of Sight (BRLOS) use cases. It is recognized that while Class G extends up to 1200 ft AGL in general and is limited to 700 ft AGL around airports with Instrument Approach Procedures (IAP), it is not obvious that the limitations of Class G would apply to these flexible operational rules while BVLOS. There should not be functional differences between these UAS flexible operations in Class G vs. UAS operations in Class E.

Recommendations

Undertake analysis of, at least, Part 91 and Part 77 to determine which regulations are applicable and appropriate for UAS operating with the flexibility of VFR while navigating solely based on instruments (i.e. current IFR). This analysis should consider the CONOPS for dynamic operations in Class G and Class E (including “Upper E”) airspace. This analysis should also consider the impact of a UTM capable of providing separation between (i) UAS with other UAS and (ii) UAS with other manned aircraft independent of Air Traffic Control.

Conduct a detailed assessment of current Class G and Class E airspace definitions and equipage and operational requirements. Changes in minimum visibility requirements, cloud spacing, equipage, and communication will all need to be considered. Conducting UAS operations BVLOS with the operational flexibility of VFR will naturally require additional Communication, Navigation and Surveillance (CNS) capabilities beyond those required for VFR operations in Class G and E airspace today, so the assessment should also consider this.

Encourage development of a path leading to airspace access above 400’ to the base of Class E and Class E, both above and below Class A. This is the airspace environment in which the value of UAS operations will reach their full potential. The need is nearly immediate and the challenges are significant. If airspace above 400’ become part of the UTM operational environment, changes to the uncontrolled aspects of Class G airspace are needed regardless of the operational capability of the UAS platform. UAS operations will be mixing with other General Aviation (GA) aircraft, and requirements for separation criteria and conflict resolutions will need to be developed. Industry must be involved in that process, to ensure that aspects unique to higher altitude operations, especially in Class E airspace above Class A airspace, are captured in the evolution of operating rules.

As we look forward, in addition to dedicated spectrum for CNPC at higher altitudes, the anticipated development of sophisticated detect and avoid technology and the transmission of payload data represent functionalities that will require significant spectrum resources. The TG/DACSC needs to begin identifying the equipage requirements and making corresponding recommendations related to available spectrum resources – including aviation-protected bands, terrestrial-based networks, and satellite communications links – essential to safe integration, FAA certification, and commercial success in this airspace.

Rationale

Airspace access is key to everything that the UAS industry seeks to achieve, but this does not stop at 400 ft AGL. No matter what happens, the introduction of UAS into the NAS will require changes to how aircraft operate in it, at least in the foreseeable future. It should be the role of the DAC to urge the FAA to begin assessing the larger impact on the current airspace definitions and requirements based on the capability of UAS technology as we can reasonably predict it will be in the next 5-10 years.

The development of UTM by NASA and other stakeholders is intended to provide the FAA with a full infrastructure to deploy for low-level operations, thereby not drawing significantly from current limited FAA resources. This infrastructure is dependent upon autonomous operations, a robust computer-based flight management and separation environment, and integrated vehicle identification technology. The extension of the UTM concept to airspace above 400 ft is natural and NASA has already indicated a willingness and interest to port the UTM model to operations in other airspace.