FOREWORD

U.S. Department of Defence Policy Board on Federal Aviation

By Fred Pease, Executive Director

Introduction

For the US Department of Defense, UAS access to national airspace is a key component to fielding skilled, ready forces capable of responding to crises both domestic and global. From high-quality, realistic crew training, to effective homeland defense operations, UAS must have daily access to airfields and airspace across the national airspace system.

Achieving that level of access, however, requires that our UAS operations are fully mature and proven safe for regular operation in a non-segregated aviation environment. Demonstrating this level of maturity requires an end-to-end approach that addresses not just the UAS, but the environment in which it operates. This is done through the application of four fundamental «tool sets» - Operational, Airworthiness, Airspace and Technology - each of which addresses a core area of competency in the both the UAS, and the larger aviation communities.

This paper will address how application of the four tool sets can result in significant gains in UAS access, both in the near-term and as an ultimate integration solution.

Operational Tool Set

The operational tool set comprises the methods, standards and environment that apply to UAS operations in national airspace.

Over the past century, the aviation environment has grown into a complex tapestry of flight rules, standards, systems and procedures. Many of these were born from the need to integrate newer platforms and technologies while still providing access to the most basic levels of manned flight. During the 1950s, for example, the aviation community had to undergo some transformation in order to accept the arrival of jet aircraft. The advent of jet-powered flight required new procedures, new standards, and a new way of looking at what aviation can do. Today, there will be similar adaptation needed in order to accept this latest of aviation applications - the unmanned aircraft.

While UAS and their pilots already fit well into a large portion of existing regulations and environments, there are gaps between the capabilities/limitations of UAS and the ability of the larger aviation system to accept them «as-is.» Many of these gaps can be addressed through the design and application of a robust set of operational procedures, flight rules, and training/certification criteria.

Perhaps the most important task in the operational tool set is the development of a common set of flight rules for non-segregated UAS operations. While many of us in the UAS community have a clear understanding of what our UAS can and cannot do, it is imperative that others share this understanding. Simply put, our unmanned aircraft must behave reliably and predictably when operating in national airspace. Pilots, air traffic controllers, and airfield personnel must clearly understand what to expect when UAS enter into their area of responsibility. Standards for emergency divert, communication loss, link loss, and other programmed actions must all be predictable and rigidly adhered to. Without ironclad standards, the resultant uncertainty surrounding UAS operations will only further delay integration and acceptance in the larger manned aircraft environment.

To compliment a robust set of operational standards and flight rules, we must also have validated and standardized criteria for UAS pilot training and certification. Training programs must develop UAS pilots that are fully versed in national airspace rules, procedures, and techniques, while incorporating those elements that are unique to UAS operations. Simply applying existing manned aircraft certification standards isn't enough…as UA systems mature, we can expect to field qualified, professional pilots that have never, and perhaps will never, fly a manned aircraft.

In lieu of manned pilot standards, tailored training criteria are needed to address specific classes of UAS operations, much as tailored criteria (Student/Private/Instrument/Commercial) are applied to manned aircraft pilots. As an example, the pilot of a 3-kilogram, low-altitude UAS may only need fundamental flight training and ground instruction to achieve certification. Conversely, the pilot of a larger, more sophisticated system operating in Class A airspace will likely require a much higher level of training and experience before being certified for those operations.

As our pilot training programs evolve to address UAS, so must our medical certification procedures. While UAS pilots, as participating members of the national airspace system, must clearly be medically fit as their manned counterparts, the specific criteria applied may need to be tailored to address UAS-specific environments. For example, since a UAS pilot conducts all operations at ground level in a stable environment, he or she may be fully capable of flight with an ear infection that might ground a manned aircraft pilot. Also, UAS safety observers, both ground and airborne, must be covered under medical policies so they may be certified to perform their flight-critical duties.

Airworthiness Tool Set

Airworthiness is generally defined as the ability of an aircraft/system to operate without significant hazard to aircrew, ground crew, passengers or to the general public. For unmanned systems that have no on-board crew or passengers, the emphasis is clearly placed upon ensuring the safety of the general public.

For manned aircraft certification, the Department of Defense has a comprehensive handbook that details the entire spectrum of airworthiness criteria. For UAS, however, many of the standards set forth in this manual have limited application. For example, requirements for pressurized cabins above a specified altitude, or for crew egress equipment, clearly do not apply to unmanned platforms. In addition, some UAS are purposely built for limited range, low altitude and low kinetic-energy applications over sparsely populated areas, making exhaustive testing and modeling both impractical and unneeded.

With such a wide range of UAS sizes, complexities, and applications, mandating the most stringent standards across the board is neither appropriate nor practical. To address this situation, the US military Services are evaluating a three-level airworthiness standard that applies a tailored set of standards that are applied based upon the complexity, size, and intended use of a given UAS.

Level One is applied to UAS that are considered «national airspace capable» and essentially applies the same level of testing and reliability standards that are applied to DoD manned aircraft. Specifically excepted are categories such as crash survivability, oxygen requirements, and pressurization. This level sets a material failure standard of 1 loss per 100,000 hours of flight, which is equivalent to the average general aviation rate of failure.

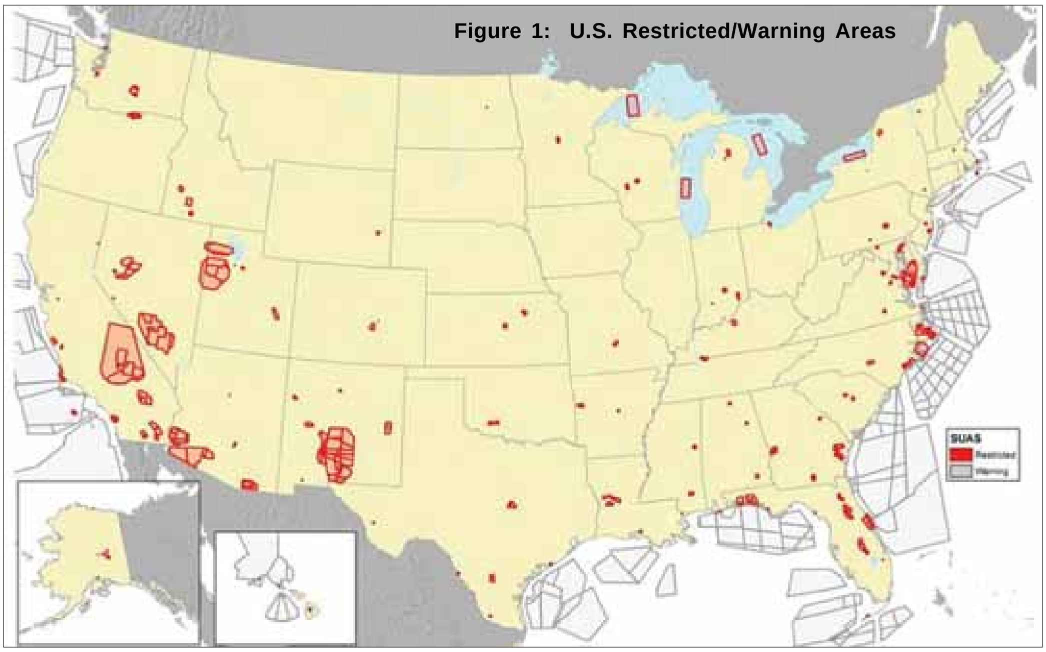

Figure 1: U.S. Restricted/Warning Areas

Level Two applies to UAS that are intended for use primarily in Restricted/Warning Areas and combat operations areas. National airspace operations for UAS falling in this category must be covered by CoA or specified agreement. This level sets a material failure standard of 1 loss per 10,000 hours of flight, with a more moderate level of statistical sampling required.

Level Three is referred to a Special Operational Airworthiness Release, and applies to DoD «small» (55 lbs or less) or experimental category UAS. This level is intended for research & development, or low-altitude/low energy applications. Due to the nature of their operations, these UAS are expected to have a higher mishap rate, and thus operational mitigations must be in place to ensure that a potential mishap does not impact public safety. Testing is focused upon ensuring the UAS performs predictably and reliably.

Using a combination of testing, modeling, and appropriate usage restrictions, the US military is able to certify their aircraft as airworthy for the operations they are intended to perform, and in the classes of airspace they are intended to fly. As always, ensuring public safety is the overriding principle guiding DoD airworthiness activities.

Airspace Tool Set

Until UA systems are robust enough to earn unfettered access into national airspace, the airspace tool set can provide effective options for many users. Airspace tools can be used to segregate UAS operations from manned traffic, or to impose a specified set of rules on mixed manned/unmanned operations. For domestic U.S. UAS operations, the singular advantage to airspace tools is that they can be leveraged today to meet existing UAS requirements.

In the US, the Department of Defense has a significant amount of designated Restricted Areas and Warning Areas available for segregating UAS operations. Nearly 150,000 square kilometers of Restricted Areas are accessible, predominantly in the Southwest and mid-Atlantic regions. Warning Areas encompass over 1 million sq kilometers of airspace along the US coastline (Figure 1).

While the overall area of Restricted/Warning Areas is significant, their use alone does not provide a comprehensive solution for domestic DoD operations. For a variety of reasons, UAS basing cannot be limited only to areas with available Restricted Areas. Some missions, such as homeland defense, may require regular access to extended areas of non-segregated airspace. In these and other cases, additional airspace tools are needed to meet the demand for more flexible UAS operations.

Where Restricted/Warning Areas are not available or not directly accessible, the DoD partners with the FAA to design specific routings and procedures that are acceptable for UAS operations. This process culminates in the issuance of a Certificate of Authorization or Waiver (referred to as a *CoA*) to enable the required UAS flights. The CoA process allows the DoD to demonstrate that effective mitigations are in place to safely allow UAS operations along a specific route at specific times. To date, the DoD has successfully applied for over 120 CoAs, making this one of the most important airspace tools available to our UAS operators.

In a major step to expand DoD UAS airspace access, in September of 2007 the DoD negotiated a landmark agreement with the FAA on UAS operations. This agreement enables UAS operations within Class D airspace at over 100 DoD-controlled military bases across the country, and is effective upon the adoption of a standard set of air traffic and operational rules. In addition, the DoD may operate smaller UAS within Class G airspace over military bases or lands. This agreement opens nearly 100,000 kilometers of additional airspace for UAS operations (Figure 2).

As part of this agreement, the DoD is partnering with the FAA on NAS integration standards, research and development, and cross-sharing of UAS safety data. The results of that partnering are expected to provide a sound basis for continued or expanded National airspace access for DoD UAS.

In addition to segregated airspace, CoAs, and agreements, the US DoD is exploring the potential use of Special Airspace Rules to address UAS operations. Special Airspace Rules are currently applied for manned operations in unique flight environments such as Alaska, the Grand Canyon, and Washington's Reagan National Airport. Defining Special Airspace Rules for UAS operations can provide for safe and efficient operations in a participative, mixed-use environment. Using Special Airspace Rules to define UAS operations areas could mitigate the long lead times associated with creating new Restricted Areas, and

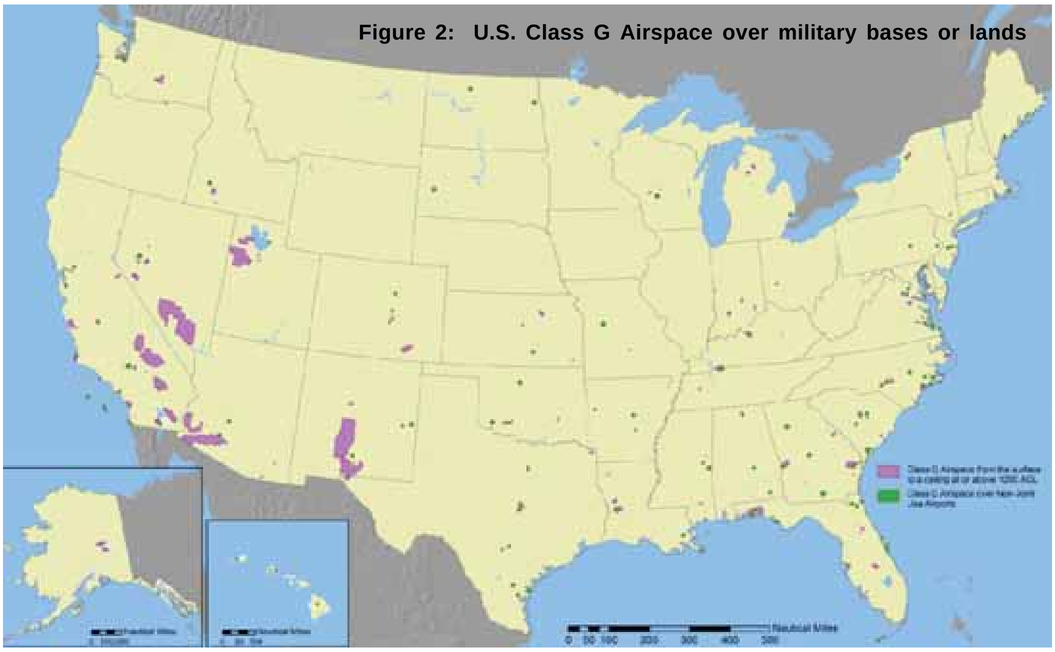

Figure 2: U.S. Class G Airspace over military bases or lands

help soften political/popular opposition to the exclusionary nature of such action.

In the near term, leveraging a robust suite of airspace tools has proven an effective approach to addressing our current UAS operational needs. Long-term, however, a more comprehensive approach will be needed to drive effective, responsive UAS operations across the spectrum of potential users in both the public and private sectors.

Technology Tool Set

Of the four critical tool sets for UAS integration, none have received more media and industry attention than technological approaches, particularly those focused upon the detection and avoidance of other aircraft. The prevailing opinion is that an on-board detection/avoidance system is the singular answer to UAS integration into national airspace.

The benefits of such a system are significant, as they apply not just to UAS, but to the entire air transportation system. An autonomous, certifiable detect-and-avoid system that is suitable for UAS use naturally has immense benefit as a safety enhancer for manned aircraft. As we look to design the next generation of our global air transportation system, such technologies will be key to absorbing increased capacity while enhancing overall safety.

Before such a system will be available, however, there is much work to be done. We have to come to agreement on what constitutes sufficient detection range on a variety of potential conflict aircraft sizes, speeds, and relative angles. We have to baseline acceptable reaction/decision times, so that developers have standard to design to. Finally, we must reach consensus on standard, predictable avoidance actions so that they may be incorporated into the appropriate algorithms. Once these actions are complete, the technology applications that will address them are likely within a few years reach.

While we strive to achieve sophisticated solutions, we must keep in mind that one size does not fit all. In many cases, a fully-capable, certified, on-board detection/avoidance system may be overkill for a given UAS application. Particularly in cases where UAS operations are either confined to a specific area, or conducted on clearly defined and repetitive routes, more near-term solutions may prove effective. Currently, the US Department of Defense is exploring the fusion of high-resolution ground-based radar systems with existing ATC radars to provide a comprehensive air picture that is granular enough to provide an effective equivalence to the «see and avoid» regulatory standard. This potential solution has particular application to those UAS which must climb to operating altitude within a limited area, or those which need to move between approved operating areas on a defined path.

Conclusion

These four tool sets, carefully developed and properly applied, comprise the foundation for safe and efficient UAS operations within national airspace. We must remember, however, that all of these tools are interdependent, and must be applied as an interwoven fabric to achieve their full potential.

While we look to future systems to address some of our challenges, we have much work to do in the here and now. Today, we must:

- Determine the specifics of our actual access requirements…where, when, and how often do we need to fly to accomplish our activities?
- Create flight standards and operations procedures that provide for predictable and safe UAS operations across national airspace;
- Baseline tiered criteria for UAS airworthiness that ensures public safety, but allows for consideration of the operational environment;
- Design flexible, responsive airspace tools that safely enable UAS operations in a variety of environments;
- Analyze the remaining requirement gaps, baseline standards, and apply the appropriate technologies to address them.

As we move through this series of steps, each increment not only opens new possibilities to improve UAS access to national airspace, but provides an opportunity to validate the gains that have already been earned. In the world of aviation, there is no currency more credible than a proven track record of safety.

These four tool sets provide a solid foundation upon which the US Department of Defense will extend that record, while setting the stage for continued advance-ments in UAS integration.