AN ACHIEVABLE PATH TO INTEGRATION OF UAS IN THE NAS[1]

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This paper analyzes the nature, geographic scope and operating limits of authorizations FAA is providing to operators of unmanned aircraft systems (UAS), and discusses why this approach is insufficient to meet the requirements of a significant constituency of UAS operators. The paper postulates that UAS integration into NAS operations is required, identifies major elements of a high level NAS architecture that would accommodate UAS integration, and proposes a new paradigm for certifying the safety of UAS integrated into NAS operations. The paper recommends work leading to UAS integration, identifies potential leadership and suggests creation of a Task Force to jumpstart this work.

INTRODUCTION: WHERE WE ARE TODAY

For decades now, the civil Unmanned Aircraft System (UAS) community has petitioned, studied, researched, demonstrated, and lobbied for regular access to the National Airspace System (NAS), to no appreciable avail. This, despite widespread acknowledgement that UAS offer significant benefits in terms of safety and economy for tasks that are too difficult, dirty, expensive, and/or too dangerous for piloted aircraft, and recognizing the potential benefits to our National economy and balance of trade by enabling and promoting an entirely new aviation industrial sector.

Under intense public pressure however and in response to a Congressional legislative directive[7], in 2014 the Federal Aviation Administration (FAA) invited segments of UAS operators to apply for exemption authority ("Section 333 exemptions") to fly UAS within line of sight (LOS) for specific commercial purposes.[8] Successful Section 333 applicants are required show that their UAS operation does not create a hazard to users of the NAS or the public[9] and argue why granting the exemption would be in the public interest.[10]

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[7] Section 333, FAA Modernization and Reform Act of 2012, PL 112-95, Feb. 14, 2012, 126 Stat. 11

[8] http://www.faa.gov/news/press_releases/news_story.cfm?newsId=16294

[9] *See* FAA Guidance for Petitions for Exemption Filed under Section 333, https://www.faa.gov/uas/legislative_programs/section_333/how_to_file_a_petition/media/section333_public_guidance.pdf

[10] 14 CFR §11.81

As of this writing, FAA has approved 99 Section 333 exemption applications, but only those seeking authority for low altitude, geographically-limited operations with non-certified UAS, over owned or controlled real estate, by operators who can remove spectators or other non-participants from the area and/or obtain liability waivers from everyone involved or overflown. And, the approvals so far require that the UAS be flown LOS only, by a certified pilot, who can personally see the UAS with eyes aided only by regular eyeglasses. FAA's long anticipated Notice of Proposed Rulemaking for Small UAS[11] would merely codify this approach of carving out permission for civil operators to use non-certified UAS at low altitudes, LOS, in segregated airspace, over property they own or control, and completely away from the non-participating or general public.

Although these conditions may be acceptable for some operations such as movie filming, some precision agriculture and stationary utilities inspection, they are entirely impractical for more expansive operations such as small package delivery companies whose business plans require automated operation beyond the pilot/operator's line of sight ("BLOS") over the general public, and where they might encounter other aircraft.[12] It has been suggested that most UAS operations can be conducted less than 500 feet above ground without encountering other aircraft. This may turn out not to be practical because this is the level of airspace where UAS are most likely to pose nuisance and privacy concerns. In fact, "opt out" listings[13] already are emerging that could create a patchwork of airspace restrictions which threaten to make operations at this level complicated at the least. What the majority of UAS commercial operators need is the ability to integrate into and interoperate with other aircraft in the NAS.

Make no mistake about it—what FAA is offering at this point is *not* integration into the NAS. And there *is no* evolutionary approach that leads from the section 333/NPRM authority to full integration of UAS in the NAS.[14] For full integration into the NAS (1) the UAS as a vehicle system must be certified as airworthy and safe for operation over the public and among other aircraft in its operating environment, and (2) the National Airspace System, including right of way rules, air traffic control infrastructure, technology and procedures must adapt and accommodate UAS along with other users. Yet today there are no FAA standards for certifying civil UAS as safe for operations in the National Airspace System. Nor are there right of way rules, air traffic procedures, or NAS infrastructure upgrades for integrating UAS operations with other aircraft in controlled airspace. And none, it appears, are in the offing.

This paper will explore (at a high level) the most important technical, infrastructure, and policy prerequisites for UAS integration in the NAS, and provide suggestions for some approaches that could accelerate progress.

ARCHITECTURE

It has been suggested that for UAS to be integrated into NAS operations, they should impose no new burdens on other operators, the air traffic control system, or air traffic controllers. This would rule out for example additional or improved NAS infrastructure or aircraft equipage, or competition by UAS with

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[11] 80 FR 9544, February 23, 2015

[12] Restrictiveness of the FAA approach is leading major potential operators such as Amazon to test their planned UAS operations outside the US. *See* "Amazon tests delivery drones at secret Canada site after US frustration," http://www.suasnews.com/2015/03/34954/amazon-tests-delivery-drones-at-secret-canada-site-after-us-frustration/?utm_source=sUAS+News+Daily&utm_campaign=4c1673b393-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_b3c0776dde-4c1673b393-303669269

[13] https://www.noflyzone.org/about . Opt out listings allow individual homeowners or localities to register an objection to drones overflying property under their ownership or control.

[14] As noted above, Section 333 authorizes FAA to grant exemptions only for LOS operations that pose no safety hazard to other aircraft or the public, thereby limiting approvals to geographically limited airspace over which the operation can demonstrate ownership and control, and where the environment can be completely sanitized of the non-participating public, and other aircraft. There is no provision in Section 333 allowing FAA to evolve this approach BLOS into NAS airspace where other aircraft operate, over the general public.

other aircraft types for NAS access. Presumably this "no impact" approach would require UAS to use mature sense and avoid/collision avoidance equipage to self-separate from all other aircraft, using whatever situation awareness capability FAA deems acceptable, and to yield right of way at all times to piloted aircraft. An architecture based on this premise is impractical given the burdensome cost to UAS operators and the inherent certification challenges involved, unfair to UAS operators who are as entitled to ANSP services as are other users of the NAS[15], and unacceptable to other NAS operators who question the safety of UAS buzzing around them absent some sort of air traffic management or control.

What then would be an optimal NAS architecture to enable safe integration of UAS into the NAS without unreasonably and unfairly burdening UAS operators, assuring safety for other operators in the NAS, and providing the most economical mix of overall system capabilities? Such an architecture would have at least the following characteristics:

Real time position determination for all vehicles (where we all are). UAS flying through ATC controlled airspace would be required to identify and report their position, the same as other aircraft. In many areas of the NAS many aircraft are not detected or identified to the air traffic system, either by secondary radar and transponder, or primary radar, and may fly without reporting position or identification to the air traffic system or other operators. In these areas, not only would small and/or fast moving UAS be difficult for manned aircraft pilots to see or avoid, but so are non-reporting aircraft difficult for UAS to detect and avoid. Knowing where UAS and GA aircraft are, even when you cannot see them visually, is essential for safe operation of both UAS and GA. Although transponder equipment poses cost and payload issues for UAS and low end GA, GPS-based position determination equipment is becoming ubiquitous and inexpensive[16]. Not only for enabling of UAS operations, but for the safety of GA as well, some minimal position determining and broadcast capability should be required of all aircraft in the NAS, both forward and retrofit. This will require a mandate imposed through rulemaking. But given the declining cost and miniaturization of the technology, the safety benefits to GA as well as UAS, and the economic incentive to the national economy of enabling an entire new class of aircraft, the overall benefits to the NAS and the national economy would make rulemaking worthwhile. The air/air and air/ground transmission must be on frequencies that are exclusively for this purpose to ensure continuity and integrity of the safety critical information, be that ADS-B or some other agreed to frequencies.

Intent information (where everyone is going). While universal position determination and broadcasting for all vehicles is a safety necessity, an important additional feature is knowing the intended direction and speed of other vehicles. This information would allow an aircraft to the minimize airspace separation buffers needed to accommodate unpredictability. To the extent flight planning and tactical routing changes are signaled to others in proximity, separations can be maintained and more aircraft accommodated in the same volume of airspace. Given that the NAS will be accommodating an entirely new, and probably large number of aircraft, airspace capacity will be a significant consideration and intent information—from all aircraft not just UAS--would be very helpful.

System wide information sharing. Whether by reporting to some sort of data sharing repository, tactical query using service-oriented architecture (SOA)[17], FAA's System Wide Information Management

[15] This is a questionable premise considering the long established policy of first come first serve when it comes to access to the NAS. And, although UAS may be a new class of vehicle in the NAS, the ultimate customers and purposes for which this new form of air transportation is used are pretty much the same as those of piloted aircraft, e.g. surveillance, transportation of cargo, and eventually possibly troops or passengers, crop dusting, firefighting, etc.

[16] *See e.g.*, Google's Project Wing, http://www.uasvision.com/2015/03/25/google-targets-low-cost-ads-b-out-avionics-market/?utm_source=Newsletter&utm_medium=email&utm_campaign=ac9c62c3ee-RSS_EMAIL_CAMPAIGN&utm_term=0_799756aeb7-ac9c62c3ee-297559073

[17]SOA is a design pattern in which application components provide services to other components via a communications protocol, typically over a network (can be web-based but does not have to be). The principles of SOA are independent of any vendor, product or technology.

(SWIM)[18] or some other network construct, universal access and sharing of position, (optimally) intent, and operating environment information will be necessary for safe UAS integration. The shared data could take the form of a display for operators, route probe and real time alerts, or eventually 4dt trajectory management, and could use the internet or a closed community network[19]. One way or another, for UAS to integrate safely into the NAS *all* operators in the NAS are going to have to share their location with others. The ATC system is the logical repository for this information. But if there are users who are uncomfortable with other operators or the government having access to identified position information on a routine basis, a private--possibly community--organization could be established to host the identification data and tag it to position information for the purpose of aircraft to aircraft communications or when otherwise operationally necessary, possibly under the supervision of an oversight body.

Airspace Management. In areas under ATC system positive control, UAS will have to be managed along with piloted aircraft. Some improvements to NAS infrastructure and ATC procedures and training will be necessary to accommodate routine access by UAS, such as reliance on digital versus voice clearances and communications, accommodating UAS speed and altitude limitations, different pilot/controller links, etc. Outside ATC positive control, UAS will be expected to self-separate on the basis of sense and avoid, aided by situational awareness based on universal position reporting, and derived from system wide information sharing. Again, awareness might on the crudest level take the form of a display of traffic in the area of the UAS intended flight path. On a more sophisticated level, a flight management system might accept and input UAS flight plans, probe current position information and other flight plans (including piloted aircraft flight plans already in the ATC system) for potential conflicts, and provide operators of UAS and piloted aircraft traffic advisories, clearances and real time alerts.[20] On the highest level, the flight management system might anticipate conflict and congestion situations, offer operators alternative routings, and ultimately sequence traffic automatically on the basis of established right of way and flight prioritization rules.[21] NASA has underway the Unmanned Aerial System Traffic Management (UTM) system program, which is developing a concept for airspace management of UAS and addressing some of these issues, but only for low altitude airspace.[22]

Spectrum. A hallmark of air traffic control and management has been that all safety of life and property communications have been carried on radio frequencies that are carefully managed to insure their integrity. It follows that air to air and air/ground/air transmissions involving UAS in the NAS be similarly accommodated and protected from interference. To do this the presently allocated spectrum will be challenged and would likely require current users to upgrade equipment to accommodate additional "beacon" codes associated with the new UAS entrants. Alternatively, the currently allocated 960-1215

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[18] http://www.faa.gov/nextgen/programs/swim/overview/

[19] See, e.g., ARINC (http://www.rockwellcollins.com/Services_and_Support/Information_Management/ARINC_Aviation.aspx) and SITA (http://www.sita.aero/products-solutions/sita-global-services/sita-data-centres)

[20] *See* Airware, http://www.technologyreview.com/news/531811/air-traffic-control-for-drones/

[21] The most promising concept for prioritizing operations in congested environments is a point system, which allocates points to various operators according to a government-sanctioned (through policy rulemaking) formula, which the operator then uses to prioritize their own operations, and to value their own operations vis a vis the preferences/values of other operators. A points market also might be created, through which operators might trade or sell/buy points, thereby buying and selling operating priorities. *See* Sheth and Gutierrez-Nolasco, "Enhancing Collaboration in Air Traffic Flow Management", AIAA 2009-7128, http://enu.kz/repository/2009/AIAA-2009-7128.pdf , and Gutierrez-Nolasco and Sheth, "Analysis of Factors for Incorporating Users Preferences in Air Traffic Management: A Users' Perspective," http://www.aviationsystemsdivision.arc.nasa.gov/publications/2010/Sheth_ATIO2010_Final.pdf . *S*ee, also, Golaszewski, Sheth, Helledy, and Gutierrez-Nolasco "Methods for Initial Allocation of Points in Flight Prioritization," AIAA 2012-5542, http://www.aviationsystemsdivision.arc.nasa.gov/publications/2010/Sheth_ATIO2010_Final.pdf

[22] http://www.aviationsystemsdivision.arc.nasa.gov/utm/index.shtml

MHz band (exclusive of the 1030/1090MHz used for ATCRBS *et al*) has, with the ubiquitous use of GPS, perhaps outlived its utility for DME/TACAN, and could accommodate UAS operations.

A NEW SAFETY PARADIGM

In general, the traditional approach to assessing and evaluating aviation safety has been prescriptive. That is, regulators/certifiers codify and use general standards or guidelines to specify product designs or development/manufacturing processes to determine whether and how a system should be certified. For UAS, the prescriptive approach has been to identify those aspects of the unmanned vehicle that cannot meet Federal Aviation Regulations (FARs) pertaining to the pilot's capabilities and role (i.e. the ability to see and avoid other traffic, and to communicate and request and receive clearances verbally), and then require the UAS proponent to demonstrate capabilities or mitigations ("alternate method of compliance" or "AMOC") that provide an "equivalent level of safety" (ELS) to the comparable pilot-on-board aircraft.[23] Equivalency is demonstrated by showing that the UAS itself performs at a level equivalent to a human piloted aircraft, or that the NAS operating environment will be as safe after introduction of the UAS as it was before the UAS was added to the system ("risk ratio" approach.)[24]

This approach is problematic for certifying the safety of civil UAS. First, determining the human capability/performance benchmark against which the UAS will be compared is far from a perfected art. Although some human performance capabilities such as visual acuity and response times can be measured objectively, other intangible human abilities such as judgement and intuition vary among individuals and are to some extent experiential. The latter are difficult, if not impossible to measure or duplicate. Second, although FAA established the baseline date of March 14, 2005[25] for NAS safety risk evaluation purposes, individual capability baselines for various aspects of the NAS on that date are not available for specific comparison.[26] And third, with the great diversity of UAS in terms of size, capability, and operating characteristics, it will be very difficult if not impossible to set universal prescriptive certification standards that will be suitable for all.[27]

A performance-based regime, focusing on desired, measurable outcomes in terms of safety,[28] and whereby the performance of diverse vehicles in various operating environments can be demonstrated, measured, and adjudged objectively, would be more practical for the regulator to implement than ELS.

The most often cited such objective performance measure is the Target Level of Safety (TLS), typically defined as the frequency of a specified event per unit of exposure (time or type of operation). A 2007 FAA policy statement[29] requires the UAS proponent to demonstrate that "a collision with another

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[23] *See* FAA Order 8900.1 CHG 351, http://fsims.faa.gov/PICDetail.aspx?docId=8900.1,Vol.16,Ch7,Sec1; Notice of Policy, "Unmanned Aircraft Operations in the National Airspace System", 72 FR 6689, February 13, 2007, http://www.gpo.gov/fdsys/pkg/FR-2007-02-13/pdf/E7-2402.pdf

[24] *See* Cole, Kochenderfer, Weibel, Edwards, Griffith, and Olsen, "Fielding a Sense and Avoid Capability for Unmanned Aircraft Systems: Policy, Standards Technology, and Safety Modeling," *Air Traffic Control Quarterly*, Vol 21 (1) (2013)

[25] FAA Order 100.161 CHG 1, http://www.faa.gov/documentLibrary/media/Order/Order%201100.161%20CHG%201.pdf

[26] FAA does publish an annual Portfolio of Goals, which provide some performance statistics and aspirational goals for various aspects of the NAS, including general aviation and commercial aviation accident rates, but these are not granular enough for AMOC comparisons. *See* https://www.faa.gov/about/plans_reports/media/FY14_POG.pdf

[27] FAA has tasked RTCA (http://www.rtca.org/content.asp?pl=108&sl=33&contentid=178) and ASTMI (http://www.astm.org/COMMITTEE/F38.htm) to develop community-acceptable standards, to date it is unclear whether, to what extent and when these activities will produce implementable products.

[28] *See* Leveson, N., "The Use of Safety Cases in Regulation and Certification", Journal of System Safety, Vol. 47, No. 6 (Nov-Dec. 2011), http://www.system-safety.org/ejss/past/novdec2011ejss/spotlight1_p1.php

[29] Notice of Policy, "Unmanned Aircraft Operations in the National Airspace System", 72 FR 6689, February 13, 2007, http://www.gpo.gov/fdsys/pkg/FR-2007-02-13/pdf/E7-2402.pdf

aircraft is extremely improbable" which equates to a TLS of 1 per 1,000,000,000 > (Probability) ≥ 1 per 10^{14}.[30] There appears to be universal community agreement however that, because of the diversity of platforms, capabilities, and characteristics of the operating environments in which UAS will operate, a universal TLS for UAS is impractical. At the least, there should be two TLSs—one for airspace where aircraft are separated by ATC services, and another less stringent TLS for airspace where GA aircraft operate under see and avoid.[31]

Using a safety regime based on variable TLSs suited to the proposed operating environments, a safety approval paradigm for UAS might be based on operator-proffered safety cases. The safety case would:

1) **Describe the UAS and its capabilities, and the proposed operating environment**, including boundaries and characteristics, other classes and types of aircraft and related equipage and ATC services if any, and the anticipated impact the proposed service will have on the operating environment, e.g. increased level of congestion, and how other aircraft and ATC are expected to interact with the proponent UAS;
2) **Propose and justify a TLS** for the proponent UAS, based on accident/incident rates prevailing in the airspace in which the UAS will operate; and
3) **Proffer evidence** that under the conditions described the UAS meets the proposed TLS (engineering and manufacturing data, simulations, demonstrations, etc.)

Accepting or rejecting the operator-proposed TLS would require an exercise of policy judgement by the regulator/certifier. If however, because of its safety mandate, the regulator/certifier has difficulty striking a balance between public safety and the reasonable business objectives of the applicant, resort might be made to a community-sponsored safety council for insight and advice on the reasonableness of the operator's proposed TLS.[32] Helping operators develop and justify the proposed TLS, and then perform and document the tests and demonstrations proving compliance with the TLS is a natural and appropriate mission for FAA-designated UAS test sites. With time these efforts would develop an historical/experiential basis on which to base later modifications, and generalized standards that might be codified.

Unlike commercial and general aviation for which safety of the aircraft occupants has been the primary liability concern, the primary third-party liability risk of UAS will be to the general public.

[30] FAA Safety Management System Manual v. 4, p.43, http://www.faa.gov/air_traffic/publications/media/faa_ato_SMS_manual_v4_20140901.pdf .

[31] *See*, e.g., the FAA Sponsored Sense and Avoid Workshop, "Sense and Avoid (SAA) for Unmanned Aircraft Systems (UAS), Second Caucus Workshop Report," January 18, 2013, which recommended a less stringent TLS for non-positive controlled airspace for the following reasons: "A single TLS would result in the highest collision risk standard TLS for all airspaces. This would have the effect of requiring UAS aircraft to meet collision risk standards so much greater than manned aircraft and certain airspaces, and thereby making UAS operations technologically and economically prohibitive to operate….It is evident from the historical accident statistics, different certification standards, and regulatory equipage requirements, that there is an implied overall collision risk difference within the NAS. Therefore, at the present, the Workshop advocates that there should be at least two (2) UAS TLS, a more stringent TLS for airspace predominately occupied by SAC aircraft, using a Separation Service Provider, flying in Class A, B, and C airspaces, and a less stringent TLS for airspace predominately occupied by GA aircraft using see and avoid, flying in Class D, E, and G airspaces." *See*, also for a comprehensive analysis of comparative risks, DoD Range Commanders Council, Range Safety Group, Standard 321-10, Common Risk Criteria Standard for National Test Ranges (2010), http://www.wsmr.army.mil/RCCsite/Documents/321-10%20Common%20Risk%20Criteria%20Standards%20for%20National%20Test%20Ranges/321-10%20Common%20Risk%20Criteria%20Standards%20For%20National%20Test%20Ranges.pdf ; and Supplement Standard 321-07, http://www.maltutty.com/content/Reference%20Material/PUBLICATION_2007_Range%20Commanders%20Council_Standard%20321-07%20SUPP.pdf

[32] *See*, for example, the Advisory Committee for Reactor Safeguards of the Nuclear Regulatory Commission, http://www.nrc.gov/about-nrc/regulatory/advisory/acrs.html

Although FAA has not heretofore required general aviation operators to carry third-party liability insurance, it would be unreasonable for FAA not to require UAS to carry insurance sufficient to protect the public against possible personal injury and property damage. Because of their smaller size, the variety of UAS and their diverse operating environments, traditional aviation underwriting analysis will not accurately reflect the risk of UAS operations. The Washington Progress Group LLC in partnership with Wilson-Clarke, Inc. has under development ways and means to overcome these problems.

THE PATH FORWARD

In all events, significant work lies ahead. As discussed above, this consists at the least of some air traffic infrastructure and procedural improvements, some (although not necessarily expensive) operator equipage, and enactment of some potentially contentious policies relating to reasonable safety standards, information sharing and airspace prioritization.[33] To do this work someone has to:

- ✓ *Revise the NAS Architecture*[34] to accommodate UAS equally with piloted aircraft including information sharing, traffic management infrastructure, and interfacing equipage not only for UAS but potentially other aircraft in the NAS
- ✓ *Parse and assign the work*, to the appropriate organization[s] or industrial sectors[s], not only R&D, technology, and infrastructure upgrades, but also enactment (by rulemaking, legislation, or both) of some potentially contentious policies relating to reasonable safety standards, information sharing and airspace prioritization
- ✓ *Arrange financing*, not just government budgets, but also operator equipage subsidies, tax incentives, user cooperative enterprises, infrastructure banks, fee-for-service arrangements, and/or private sector investment, ownership and operation of publicly used infrastructure, etc., and
- ✓ *Perform, integrate, implement and manage* work of the collective enterprise, including programs and projects, policy initiatives, and private sector collaborative enterprises.

CONCLUSION

Judging from the geographic scope and operating conditions of the applications FAA has approved so far, it may fairly be concluded that Section 333 exemptions are not going to satisfy the needs of most UAS civil operators.[35] To achieve their business objectives, most operators will have to operate BLOS, at various altitudes, using increasing levels of automation, and fully integrated with other operations in the NAS. And being a class of NAS operators equal with piloted aircraft, the UAS community should demand—and accept--no less than full integration, even if this means some accommodations or concessions from other NAS users.

Market surveys, mission analyses, and demonstrations in restricted or sanitized airspace are primarily useful for crafting workarounds or mitigations that address some UAS users' immediate needs short of

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[33] The authors are agnostic with respect to how or by whom (government or private sector) any of these tasks are performed, or whether the resulting capabilities are human functions or automated. Given the volume, complexity, and time criticality of services described, it is suggested that most of the functions will almost immediately exceed the capability of human operators, and that advancing levels of automation are inevitable. *See* National Academy of Sciences Report "Autonomy Research for Civil Aviation" (2014), http://sites.nationalacademies.org/cs/groups/depssite/documents/webpage/deps_144680.pdf; download at http://www.nap.edu/catalog/18815/autonomy-research-for-civil-aviation-toward-a-new-era-of

[34] https://nasea.faa.gov/

[35] We have already seen a huge potential operator Amazon leave US soil to test its much anticipated package delivery system using small UAS. http://www.suasnews.com/2015/04/35076/amazons-drones-exiled-to-canada/?utm_source=sUAS+News+Daily&utm_campaign=8abd73e69e-RSS_EMAIL_CAMPAIGN&utm_medium=email&utm_term=0_b3c0776dde-8abd73e69e-303669269

full airspace integration. These activities should not be confused with progress toward meaningful integration and they should not distract attention or substitute for the real work of NAS integration, the major components of which are pretty much already known.

As of this writing, no one has assumed responsibility for UAS integration into the NAS, and no one is leading. And unless the UAS community does, no one—including FAA—will. The UAS community itself must self-organize; clarify, mature, and articulate collective requirements; advocate forcefully and effectively at all levels of government to have those requirements addressed; and claim their rightful place as an *equal* operator class among NAS users. UAS advocates will encounter significant controversy and opposition along the way, because as discussed herein UAS will be competing with other users for access to airspace in congested environments, and accommodation of UAS in the NAS may well require additional equipage and cooperative procedures by other operators.

Consider historical models: Airlines for America (A4A) (formerly the Air Transport Association) for commercial airlines; the Aircraft Owners and Pilots Association (AOPA) for general aviation; National Business Aircraft Association (NBAA) for business aviation; and the General Aviation Manufacturers Association (GAMA) for general and business aviation manufacturers. All of these organizations, individually and collectively have assumed public leadership, marshalled collective energy, matured and articulated with one voice their members' technical/operating/policy needs, and advocated forcefully—and very successfully--with the Administration, Congress and FAA for the interests of their constituencies.

The UAS community should designate and empower the Association for Unmanned Vehicle Systems International[36] (AUVSI) to assume a comparable leadership, technical, and advocacy role for the UAS community. The authors suggest that a good way to begin would be for AUVSI to organize and host a UAS Integration Task Force, to jumpstart the work enumerated in the "Path Forward" section of this paper. Such a Task Force should include experts in NAS technology and engineering, safety, and finance, as well as individuals and companies knowledgeable about UAS platforms and operations. AUVSI might consider seeking FAA sponsorship of the Task Force as a Federal Advisory Committee.[37] The factors to be considered and process pertaining to such a designation are beyond the scope of this paper.

[36] http://www.auvsi.org/home
[37] Pub. L. 92-963, 5 U.S.C. App. *Cf.*, RTCA charter renewal, 80 FR 18492, April 6, 2015.