

UAS INTEGRATION: FLYING WITHOUT A PILOT

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Introduction

“Airspace integration and de-confliction, especially as UAS become ubiquitous to aviation operations, are growing issues affecting not only military operations, but civil operations as well.”¹

This was the conclusion of the recently released National Plan for Aeronautics Research and Development, which named UAS integration in the national airspace as a national objective. Similarly, an independent market analysis firm specializing in aviation and defense named UAVs “the most dynamic growth sector of the world aerospace industry.”² *Aviation Week and Space Technology* magazine has concluded “the idea of employing aircraft in the national airspace without pilots aboard them... has gotten to a point where their introduction is considered inevitable.”³

Notwithstanding unequivocal federal policy direction, upbeat market assessments, and compelling trade press observations, UAS integration in the national airspace is stuck in a rut. Anyone versed in the subject will confirm that, apparently inexplicably, little work is taking place, either in government or the private sector, to make UAS integration in the national airspace a reality.

The following discussion postulates why real progress on UAS integration is not happening, even though UAS are high on the shopping list of the Department of Defense (DOD), civilian federal agencies, and local law enforcement. We also explore why this lamentable situation is not likely to change any time soon, irrespective of community wide excitement over the promising military and civil UAS applications. And we propose a public-private partnership construct for breaking through the impasse.

¹ National Plan for Aeronautics Research and Development and Related Infrastructure, December 2007, pg. 17, *see* www.aeronautics.nasa.gov/releases/aero_rd_plan_final_21_dec_2007.pdf

² The Teal Group, 2008 UAV Market Study

³ UAVs, or Nothing Can Go Wrong, Go Wrong, George C. Larson, *Aviation Week and Space Technology*, Jan 29, 2008

Demand for UAS Access to the NAS Is Growing

Public entities urgently want to use UAS in unrestricted airspace for fire fighting, post-disaster scouting, resource management, global warming studies, and border patrol.

Federal agency requests for Certificates of Authorization (COA) to fly UAS in the NAS have nearly doubled in each of the previous few years, and the demand curve is increasing. Since 2005, the Department of Homeland Security's (DHS) Customs and Border Protection has been flying two Predators over the US southern border, and in 2008 it will add two more to survey the US northern border. The National Oceanic and Atmospheric Administration (NOAA) included \$3M in its FY 2008 budget for UAS activities relating to the collection of environmental data. In 2007, one hundred National Aeronautics and Space Administration (NASA) and NOAA-sponsored scientists gathered in Boulder Colorado to share lessons learned about using UAS, and to increase their advocacy for UAS integration.⁴ NASA flew its Predator over California wildfires last year to map the path of devastation. In FY 2008, NASA will acquire two Global Hawks, which it intends to lease out to other federal agencies.

After several police departments were found to have operated small UAS without advance authorization, the FAA clarified that law enforcement agencies may – indeed *must* – seek a COA before conducting such flights in the NAS.⁵ Donald Shinnamon, Chairman of the Aviation Committee for the International Association of Chiefs of Police (IACP), the world's most longstanding and largest nonprofit organization of police executives, predicts, “once we overcome this regulatory issue, I honestly think the use of this technology will explode at the local government level....”⁶

Trouble Ahead

Trouble is ahead for UAS operators because, at least for the immediate future, competition for access to the NAS by all vehicles, piloted and unpiloted, is predicted to increase. Meanwhile, FAA resources for certifying and approving new aircraft and operations are not increasing in a commensurate way. Only a few months ago, the FAA told an industry group that a lack of resources constrains the agency's ability to support UAS users today, or to develop policies that will pave the way for routine access to the NAS in the future.⁷ The FAA warned that the number of COAs it could process (under which limited UAS operations are permitted) would necessarily reduce by half in 2008 (from 65 to 35) because of resource constraints.⁸ This would prevent a significant

⁴The Symposium on Civilian Applications of Unmanned Aircraft Systems, University of Colorado at Boulder (October 2007).

⁵ 72 Federal Register 6689, February 13, 2007, <http://edocket.access.gpo.gov/2007/E7-2402.htm>

⁶ CNET News. *Police Agencies Push for Drone Sky Patrols*, by Anne Broache, August 9, 2007.

⁷ Presentation by John Hickey, FAA Director of Aircraft Certification, before AIA Subcommittee on UAS, October 2007.

⁸Ibid.

number of federal agencies (and potentially law enforcement) from conducting many helpful UAS missions.

Private concerns planning to fly UAS in the NAS can now do so only pursuant to an Experimental Certificate,⁹ which is granted only for the limited purposes of research and development or training. The FAA says it plans to handle four such requests in FY 08, *seven fewer* than the previous year.

At the present time there are no general rules stating the conditions under which UAS can be certified for operation in the NAS for commercial purposes.¹⁰

European governments and agencies on the other hand are moving out smartly on UAS integration. It was reported in January 2008 that the European Defense Agency (EDA) completed a study projecting that UAS will be able to interoperate with manned aircraft in European civilian airspace in eight years. EUROCONTROL announced that it will provide “clear direction and leadership to the UAS integration issue” because “it is becoming rapidly apparent that the pan-European ATM network will be required to accommodate UAS as legitimate airspace users.”

Privately, US UAS companies admit they are frustrated. Some report they have had to turn away lucrative sales because they cannot deliver assurance that the UAS will be able to operate in the US NAS.¹¹ A surprising number say they are prepared to move business operations overseas where the prospects for testing, certifying, and selling their products are more promising.

What Is Being Done About It

If truth be told, despite public expressions of concern and a proliferation of disconnected and unfocussed activities, very little real progress is being made on NAS integration.

ACCESS 5—NASA’s 5-year program aimed at introducing UAS into the NAS on an evolutionary basis starting with high altitude operations—was suspended in early 2006, just one year after its initiation, as NASA redirected financial resources to the Administration’s Return to Space program. It was presumed that DOD or other

⁹ 72 Federal Register 6689, February 13, 2007, <http://edocket.access.gpo.gov/2007/E7-2402.htm>

¹⁰ UAS do not satisfy existing regulatory standards for manned aircraft and the FAA has not clarified how UAS could demonstrate that they operate with an “equivalent-level-of safety” to manned vehicles. UAS manufacturers and operators say they cannot afford the financial uncertainty and risks involved in the traditional “bring me a rock” certification process that is based on the applicant for certification of a new technology proposing the applicable standard where existing standards are inapplicable or insufficient. The result is a Catch-22 in which FAA waits for UAS candidates to apply for approval, while candidates wait for the FAA to define the standards to which they must build.

¹¹ For example, Stephen Sliwa, CEO of Insitu, a UAS manufacturer located in Bingen, Washington, testified on March 22, 2007 before the Subcommittee on Aviation, U.S. House of Representatives Committee on Transportation and Infrastructure, that his company has turned away contracts for tens of millions of dollars due to lack of airspace access.

agencies with near-term needs for integrated UAS operations in the NAS would pick up the mantle. This has not occurred.

In 2004, FAA initiated the RTCA Special Committee 203 and tasked it with developing standards for avionics (sense and avoid, command and control, and communications systems) and procedures that will allow UAS to perform in a way equivalent to manned aircraft, paving the way for their integration in the NAS. Over three years into this effort, SC 203 has yet to deliver substantive products. SC 203 is a volunteer effort and is slowly evolving Minimum Operational Performance Standards (MOPS) and Minimum Aviation System Performance Specifications (MASPS). Under its current schedule, recommendations will not emerge until 2011.¹²

In 2006, FAA announced development of a five-year roadmap to UAS integration, covering the current state of UAS mission needs, a forecast of their near-term demands on airspace capacity, and a strategic plan to safely integrate their operations into the nation's airspace. A study was undertaken, but the roadmap widely promised in 2007 has yet to be released.¹³

In 2008, FAA initiated yet another activity, standing up a targeted ARC (Administrator's Rulemaking Committee) to develop policy on integration of small UAS into the airspace. Since small UAS present the same, if not *more* difficult integration issues than larger, more sophisticated UAS, it remains to be seen what useful outputs, if any, this new forum will deliver.

Late in 2007, FAA and DOD signed a memorandum of Understanding (MOU) designed to expedite military UAS access to unrestricted airspace. The DOD has stated that it will pursue whatever measures are necessary to assure UAS operations in the NAS for military missions, but those solutions will not open the door to operations of UAS for civil and commercial purposes.

In summary, activity that realistically could enable civil and commercial integration of UAS in the NAS is neither underway nor planned.

Why the impasse?

So what, exactly, is impeding real progress?

To start with, no federal agency is specifically charged with the responsibility for enabling routine UAS operations in the national airspace. Neither is any one agency sufficiently invested in access for its own vehicles to seek this leadership role. The work needed to develop inter-related technology, policy, and operational solutions cuts across traditional agency missions. Moreover, there is no existing venue for collaborative effort aimed at defining the necessary integrated solution set. In a real sense, organizational stovepipes are getting in the way of progress. Industry is not

¹² Thereafter, manufacturers will be expected to seek certification of products based on the applicable standards. Regulatory approval could take years.

¹³ www.faa.gov

mounting the kind of sustained joint effort necessary to bring forward fully validated solutions, largely because the leading UAS manufacturers are primarily focused on defense missions that do not depend on routine access to the NAS. Without a motivated champion, few if any resources are—or will be—applied to NAS integration challenges.

Second, actors in the UAS integration drama are in conflict about *who* should lead. Technology developers say they need fairly specific regulatory requirements and standards to which they can build before they will invest time and resources on system development and pursuit of certification. Guessing wrong about requirements can be both risky and expensive. The FAA can respond only to a concrete application, e.g., for certification of a product, or an exemption to a particular rule or standard, *supported by data*. The promulgation of general rules and standards will not obviate the requirement that specific vehicle systems be presented for approval to interoperate with piloted aircraft in the NAS. Of course both sides are right according to the logic operating in their own worlds, but the result is a de facto impasse.

Third, there is enough third-party opposition to UAS integration to cool the ardor of any potential proponent. Airline pilots fear loss of jobs; private pilots worry about colliding with unpiloted vehicles. Air traffic service providers and commercial operators are concerned about adding an entire new category of aircraft to already overcrowded and increasingly complex airspace. Certifying officials face more than enough to do in processing authorities for the increasingly diverse universe of manned vehicles, and therefore hardly relish even more applications from a challenging new category of aircraft with diverse platforms and operational capabilities. Many understandably dread, if not actively resist, integration of UAS in the NAS.

Fourth, many who call for UAS integration have found a way of doing without it. Government operators use special use airspace or limited COA authorizations for UAS missions in the CONUS, and UAS manufacturers have been satisfied enough with military bookings to forego the financial risks of certifying for an uncertain civil market.

Finally, UAS integration in the NAS *will* require solutions to some very difficult technical challenges. For a remotely piloted aircraft to operate in an equivalent way to a piloted one, the communications link must be failsafe and secure, and technology and procedures must be developed that will allow a compromised UAS to be recovered safely, i.e., landed or ditched without interfering with other air traffic. UAS additionally will need backup operating capability with perception (see and avoid) and cognitive (command and control) capabilities equivalent to the human pilot. And, on the regulator's side, a baseline of human capability must be developed and documented against which to measure the performance of UAS. Metrics, rules, and standards must be promulgated stating what level of capability a UAS must demonstrate in order to earn approval.

Breaking the Stalemate

So, who *will* pilot UAS integration?

In 2006, a group of distinguished aviation leaders came together in the Center for UAS Integration (the Center) to offer an innovative strategy for overcoming the apparent stalemate that prevents UAS from flying in the NAS.

Principals at the Center observed that stakeholders with various, sometimes conflicting, interests and very diverse types of vehicles and missions seemed to be locked in endless debate about generalized rules, standards, and procedures. No attention was being devoted to developing a practical strategy for doing the work—technology development, simulations, flight-testing, data analysis and documentation—that would support those rules and standards.

The Center, building on experience using collaboration models to successfully overcome barriers and speed progress of difficult multi-agency projects, offered an innovative construct for accelerating UAS integration. The Center’s plan was to bring all partially invested stakeholders together into a cohesive public-private partnership greater than the sum of its parts. And, rather than pursue the elusive generalized solution, the partnership would achieve UAS integration by advocating for the sequential integration of individual pioneer UAS. The result would be near-term precedents that would serve to initiate UAS integration and provide the basis for the expansion of routine UAS operations in unrestricted airspace.

The Approach: National Center for UAS Integration, a Public-Private Partnership

Structurally, the National Center for UAS Integration would be a public-private partnership consisting of three essential elements:

- **A national lead agency** to elicit and prioritize requirements relating to UAS operations among current and potential UAS operators, including federal departments, state and local governments, and potential private sector operators, and to establish national policy as it relates to UAS integration. It is recommended that the Department of Transportation assume this leadership role, as Chair of an Interagency UA Council.¹⁴
- **A Federally funded program**, sponsored by the lead federal agency, dedicated to performing and integrating all of the work required to groom and guide pioneer UAS through the regulatory process as precedent-setting agents for UAS integration. The program would include maturation of critical technologies (such as the command and control, and see and avoid technologies) and operating procedures, test and evaluation, data collection and analysis, and preparation of

¹⁴ The Center advanced the notion of DOT as the sponsoring agency rather than FAA, in order to preserve the FAA from being in the position of both advocate for and regulator of UAS. FAA leadership over the national UAS Center is by no means foreclosed. NASA is another logical choice.

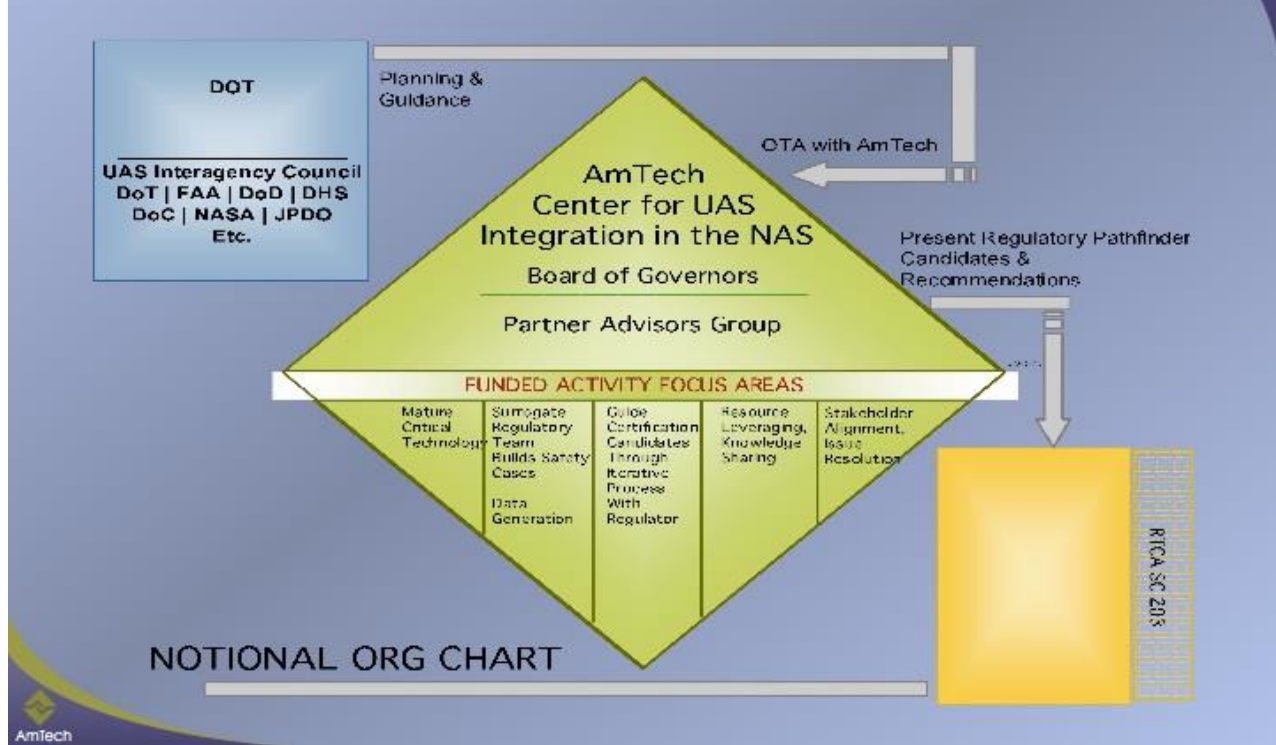
documentation necessary to demonstrate to FAA that the pioneer aircraft can be operated safely in the NAS¹⁵.

- **A central organization**, acting on behalf of the entire stakeholder community, to orchestrate and integrate the players and work-products required to successfully advocate for certification of individual pioneer UAS. With sponsorship from the national lead agency, and in coordination with appropriate stakeholders, the central organization would: (1) coordinate and integrate necessary R&D work taking place in various laboratories, universities, and private companies; (2) help proponents develop and postulate the appropriate standards and operating procedures applicable to the particular case; and (3) guide proponents in the preparation of documentation required for FAA approval, such as studies, simulations, and in-field tests. In addition, the central organization would orchestrate a forum (Stakeholder Advisory Council) to identify, address, and mediate concerns of other NAS operators and the public about safe operations of UAS in the NAS.

A notional organization for the public-private partnership, including workflow, is depicted below:

¹⁵ Pioneers would primarily be selected from among Government owned and operated UAS that conduct missions in the NAS, but other candidates could serve as well.

THE COLLECTIVE ENTERPRISE MODEL



The concept of driving UAS integration through pioneering, precedent-setting cases offers several advantages. First, a pioneer case narrows the range of issues to a manageable level. Second, it presents a concrete example that can be effectively evaluated for safety, as opposed to an unwieldy collection of abstract rules that must be general enough to apply to many instances and many different UAS types. Third, it allows FAA to utilize established certification processes to judge the safety of new technology entrants (“equivalent level of safety” determination). The goal is to enable timely, effective, low-risk decision-making. The experience and data derived from these precedent setting cases would ultimately be used to develop verifiably sound universal standards and rules to enable integration of many UAS vehicle types and missions.

The National Center for UAS Integration concept also addresses all of the issues listed earlier as current impediments to progress:

- UAS pioneers will serve as agents of progress, triggering seminal decision-making that will gradually evolve toward full UAS integration. The certifying organization will no longer await proponents who fail to appear because of the perceived costs and risks of certification when the regulatory environment is uncertain. Each pioneering case advances UAS integration with real results, and

informs development of standards and procedures that can be applied to the next group of UAS integration candidates.

- No more ambiguity about who should lead. The public-private collective enterprise will be the champion for UAS integration. All UAS stakeholders will benefit without any single one being asked to exceed its own organization's threshold of responsibility for UAS integration.
- The pioneer case approach will focus UAS community effort on results-driven work that will yield safety data to support rules and standards development, rather than unproductive and costly debates over generalizations.¹⁶ The data generated will flow to RTCA SC 203, the FAA ARC on small UAS, and other efforts.
- Third-party stakeholders with concerns about UAS integration in the NAS will have a forum *within* the Center to raise issues and help craft practical solutions, rather than resort to public opposition. Confidence in the safety of UAS interoperations with manned aircraft will be fostered, as each pioneer is safety integrated into the NAS.

Conclusion

Peter Drucker, the renowned father of modern management theory, observed “plans are only good intentions unless they immediately degenerate into hard work.” That philosophy should resonate with the aviation community, which is famously a “show-me” province. Pronouncements about the importance of integrating UAS into the national airspace do not alone inspire action and results. This national goal must be connected to real applicants for certification, concrete systems, and hard safety data if it is to yield progress.

While today UAS integration may be unpiloted and lack a compass, the path forward is clear.

¹⁶ For \$1 million the DOD was able to mature and test the performance features of an emerging sense and avoid system. The results effectively countered a widespread notion that this critical technology will require as much as \$1B and ten years to develop. It is powerful evidence that modest investments strategically deployed can bear transformative results. There are few published studies that attempt to quantitatively assess the empirical relationship between innovations in unmanned vehicle systems and actual gains in performance.