FAA, Tear Down that (Airspace) Wall !

by Frank L. Frisbie and Suzette Matthews[1]

Print media, conference outlets, and a host of internet information sources bombard the aviation community with dazzling "new developments." All kinds of new and improved aircraft—faster, more capable, greener, cheaper to operate, more accessible to less and less knowledgeable operators—are moving rapidly from the imagination of futurists into the realms of reality. Not so long ago, today's reusable launch vehicles, unmanned, and fully automated craft were considered science fiction. Jetson-like personal flying cars, airborne "yellow cabs", robot air "pizza delivery" cargo operations, and surveillance craft as small as birds, are now a reality, either matured, under development, or in the concept stage.[2] Open-minded, future-embracing regulatory and industry experts are struggling how to get them safety certified and implemented into airspace still designed for, and capable of accommodating only piloted vehicles--and only limited numbers of those at that.

This maelstrom calls out for leadership and rationalization by a willing, modern, and technically capable airspace regulator and operator. Yet, today, "futuristic" aircraft segments are frustrated by an airspace regulatory construct that relegates them to segregated airspace operations, and/or equipage and procedural barriers that thwart their practical potential, and relegate them to permanent second class status versus conventional legacy operators.

For example, there is little to show for four decades of industry efforts to fully integrate capable unmanned aircraft into positively controlled airspace. Instead, the 2020 FAA published UTM Concept of Operations[3], developed with industry under NASA auspices, settles for widespread operations only in segregated, non-controlled airspace. To enter controlled airspace, the unmanned aircraft—regardless how maneuverable and capable—is forced back into today's legacy command and control environment with all of the equipage and certification baggage that entails. Even within this geographically bounded construct, there are at least five issues (safety certification and assurance, UTM regulatory authority, financing, access prioritization in conflict situations, and third-party liability) that FAA must resolve before UTM airspace becomes operational—*none* of which, to the authors' knowledge, are even at this point being addressed.

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[2] *See* https://www.uasvision.com/2021/12/17/seven-strange-machines-that-actually-fly/; *https://successnews.online/companies/boeing-expands-focus-on-air-taxis/*

[3] https://www.nasa.gov/sites/default/files/atoms/files/2020-03-faa-nextgen-utm_conops_v2-508_1.pdf

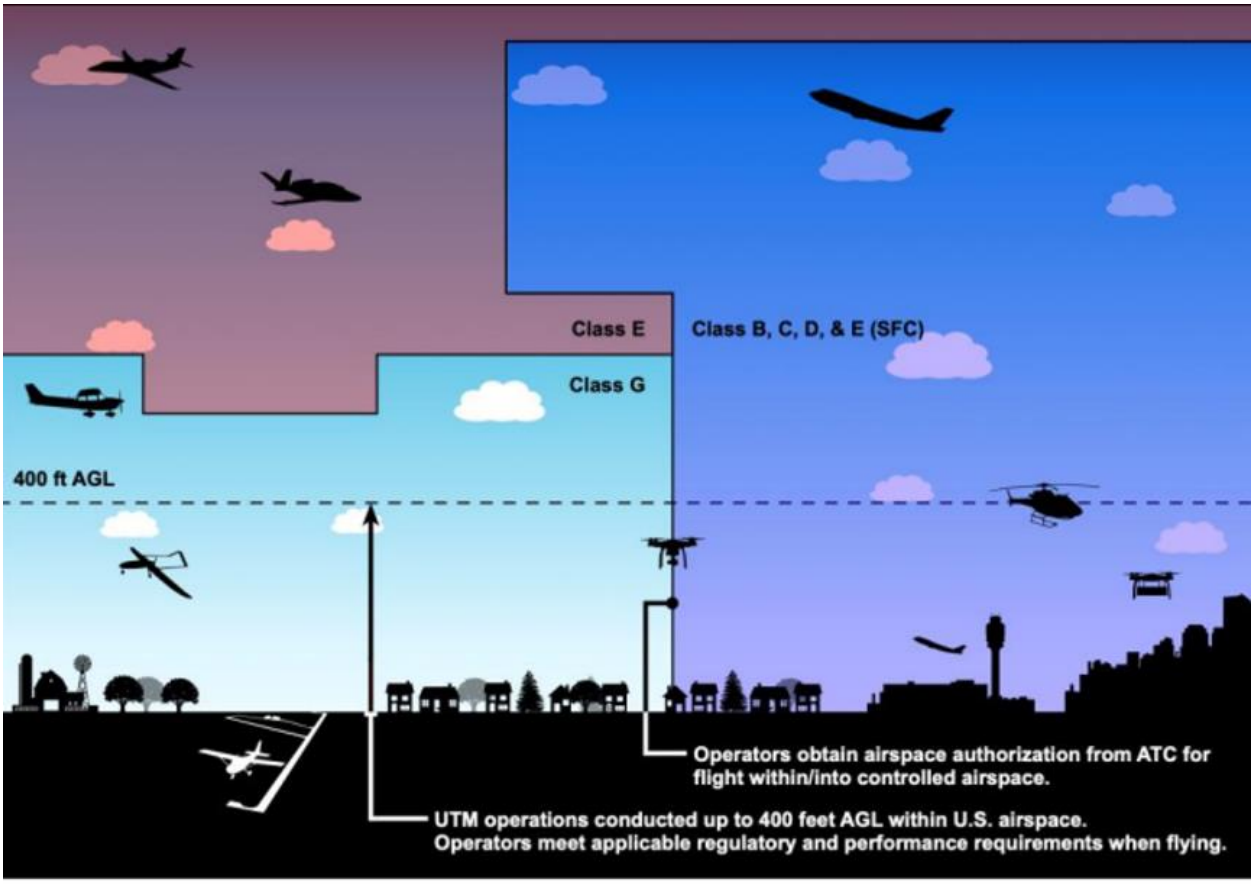


Figure 2. UTM Operations in context of airspace classes

Likewise, under the FAA-published 2020 Commercial Space Concept of Operations[4], space-capable aircraft face a graduating progression into controlled airspace starting with confinement in special use airspace, to conventional ATC on the basis of the aircraft's potential break up debris field to, finally, treatment equal with conventional aircraft. To its credit, the Commercial Space community will not settle for a prolonged future of segregated operations. Rather Commercial Space advocates enumerate in their Con Ops those improvements to the airspace system that are necessary for fully integrating their aircraft into the NAS, pointing the way to a 4DT NAS as the only really practical, long-term solution.

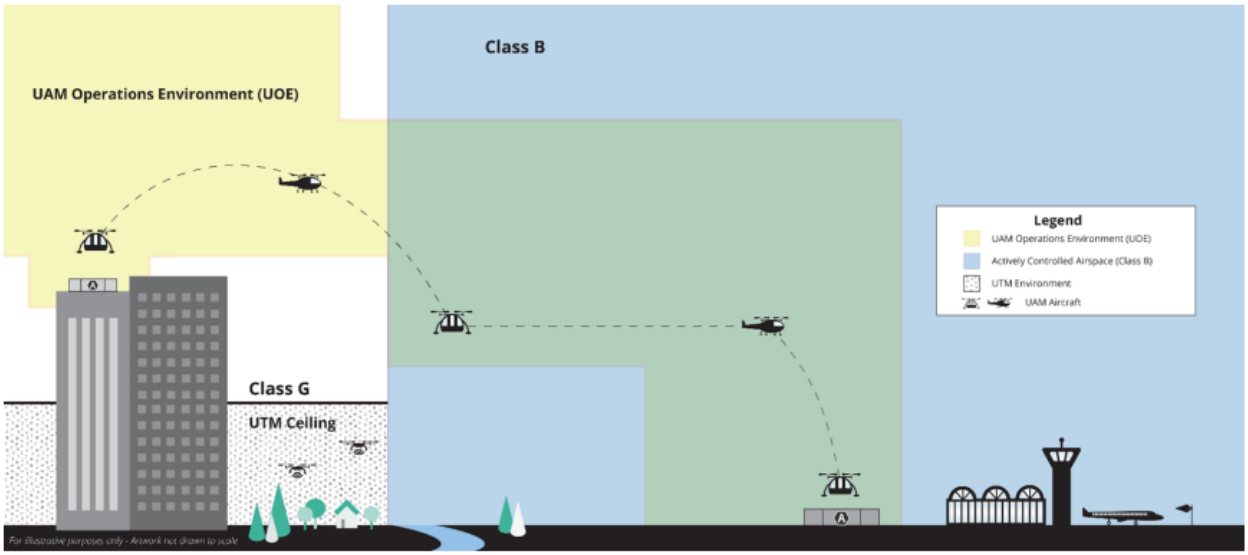
NASA's Urban Air Mobility Con Ops seeks to analyze airspace management requirements, and develop an operating concept for the diverse craft envisioned for complex, congested urban airspace. At this point however, it is only at the "vision" stage.[5] Consistent with recent practice, this task again is falling to a diverse, unorganized body of industry advocates, led by NASA and supported by a professional contractor. If the past is any indicator, the FAA will step in only to draw geographic boundaries around that airspace, and signal a regulatory head shake to any attempts to create a seamless border between that

[4] https://www.faa.gov/space/airspace_integration/media/Final_CSINAS_ConOps.pdf; https://www.faa.gov/space/airspace_integration/

[5] https://ntrs.nasa.gov/api/citations/20205011091/downloads/UAM%20Vision%20Concept%20of%20Operations%20UML-4%20v1.0.pdf.

area and controlled airspace. This effort's umbrella Advanced Air Mobility Project[6] will confine itself to being "a community catalyst and developing and validating system-level concepts and solutions," not a hands-on regulator, certifier, or ATM technology or service provider.[7]

Figure 5: Side Operational View of a Representative UOE



This graphic shows the entry into actively controlled (Class B, C, or D) airspace to reach a UAM aerodrome co-located with an airport. UAM approaches and departures have been designed so that they do not interfere with the approaches and departures of commercial jets. When flying in these areas, UAM aircrafts obtain their traffic management services from the PSUs, but also must be properly equipped to communicate with ATC (in off-nominal situations). In addition, the UOE and UTM do not actively exchange data at UML-4.

FAA's current path of dividing aviation segments into buckets (by aircraft type, geographic area…whatever distinction seems to apply), and then outsourcing the requirements and con ops work to NASA, with input of industry advocates, abdicates the agency's policy and leadership responsibility. This practice is likely to produce theoretical airspace management and control constructs that are simply impossible to reconcile, and wasteful to implement. The only observable FAA organizing principle appears to be that, operators of "futuristic" aircraft can plan together on paper whatever they want, as long as they "become" conventional aircraft at the boundary, and conform with all the FAA requirements, procedures, and limitations, regardless whether that makes sense. But today's NAS, despite upgrades underway and study of "Extensible Traffic Management"[8] for deployment in an undefined future is simply not good enough to support aircraft already awaiting in the wings.

[6] https://www.nasa.gov/aeroresearch/programs/iasp/aam/description/

[7] FAA recently re-chartered the Drone Advisory Committee (DAC) as the Advanced Aviation Advisory Committee (AAAC), to include advanced air mobility integration issues in addition to UAS issues, and increased its membership to 41. https://www.faa.gov/uas/programs_partnerships/advanced_aviation_advisory_committee/ . Its charter is available at https://www.faa.gov/uas/programs_partnerships/advanced_aviation_advisory_committee/media/AAAC_Charter_Amendment.pdf .

[8] "This project will investigate and analyze future Extensible Traffic Management (xTM) services that allow for new entrant operations and technologies to co-exist with conventional Air Traffic Services (ATS), by the sharing of fully integrated and interoperable digital information. It will address the operations of select new entrants within

Federal Law assigns to the FAA the authority and responsibility of creating, and operating the National Airspace system for the safety and efficiency of all operators.[9] Since the inception of positive control in 1936[10], this includes the service of separating aircraft from each other in controlled airspace. It's time to stop segregating aircraft operators and operations into interest groups, farming out the concept and architecture work, and balkanizing the airspace in an attempt to mollify the loudest critics. Rather, FAA itself should resume the task of designing, architecting, building and operating one capable, seamless NAS that can accommodate all operators--legacy and newcomers.

First and foremost, let's jettison the idea that today's airspace and ATM construct is an acceptable end state.[11] Instead, in order not to disturb the existing order, the various FAA-sponsored con ops relegate newcomers to segregated airspace, and offer them the opportunity to "self-separate"—the new lexicon for "free flight." This technology has, and is, proving to be the most difficult challenge possible, especially in an environment of unprecedented aircraft diversity, and legacy users and partial equipage. Even if self-separation can be made to work in segregated, sparsely populated airspace, the concept breaks down entirely in densely populated airspace such as terminal and urban environments where many operators will be contending to fly over the same point in space at the same time. Not to mention the supremely

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dynamically segregated airspace…." Briefing, REDAC / NAS Ops Enterprise Concept Development BLI Number: 1A11A Presenter Name: Steve Bradford, ANG-3 Date: August 31th, 2021 Review of FY 2021 - 2024 Proposed Portfolio, file:///C:/Users/smatt/AppData/Local/Microsoft/Windows/INetCache/Content.Outlook/HE6NIXQF/nasOps_aug2021_03FALL2021NASOPSREDACBriefing-EnterpriseConcept.pdf.

[9] 49 USC §40103, https://www.law.cornell.edu/uscode/text/49/40103; 49 USC §1.82, https://www.law.cornell.edu/cfr/text/49/1.82 . See also 51 USC §40113, on FAA's responsibility for airspace systems research, https://www.law.cornell.edu/uscode/text/51/40113 .

[10] Eno Center for Transportation, "A History of Air Traffic Control Provision in the United States" (2016), https://www.enotrans.org/article/history-air-traffic-control-provision-united-states/

[11] FAA's vision of the NextGen NAS gets more and more regressive. The FAA's NextGen Annual Report 2020, (https://www.faa.gov/nextgen/media/NextGenAnnualReport-FiscalYear2020.pdf) pp. 32-37, describes TBO as just an increasingly sophisticated decision support tool (DDS) to the legacy human-operated command and control ATC system. This is a far cry from the JPDO 4DT TBO, or even the 1980s NAS Plan Advanced Automation System (AAS), which envision a future end state in which the 4DT automation uses real time operator intent information to reconcile and deconflict user-determined routings, both strategically and tactically, and then monitor for conformance with those instructions for rerouting or positive control if necessary. The FAA 2020 vision seems never to make the leap from human-operated to automated 4DT control, which will be necessary to integrate fully into the NAS the number and diversity of advanced aircraft now existing and envisioned for the near future. Likewise, extending out to 2035, FAA's "A 2035 Vision for Provision of Air Traffic Management Services" never reaches full integration of today's, and future advanced vehicles into the NAS: "Accommodation of new entrants does not imply full participation within the entire ATM system. Rather, the simultaneous co-existence and interoperability of diverse collaborating traffic management services with conventional Air Traffic Services (ATS) is expected to cost-effectively enable these future operations." And to the extent FAA envisions 4DT ATC in the 2035 environment, it would be a conglomeration of public and private services, not one comprehensive NAS capability: "The increasing demands of air traffic volume, diversity, and complexity make ATM automation services ever more critical. The need for automation services will be met by combinations of technology advancements such as cloud-based services, edge intelligence, and certified remote operations enabling cost-effective ATM automation capabilities to be provided wherever needed." https://solutions.atca.org/wp-content/uploads/2020/09/Preliminary2035VisionforATMService-PRS.pdf Imagine the difficulty for aircraft operators of planning and updating ATC-facing equipage in such a fluid and complex ATC service environment.

complicated problem of integrating those self-separating aircraft into the traffic flow at boundaries with the currently controlled NAS. And perhaps most damning of all for this construct is that it forces newcomers to equip with not only one (problematic enough), but *two* sets of sophisticated avionics—one for self-separation, and another for integrating into controlled airspace. Indeed, the oft ignored stumbling block to NAS modernization is the aircraft fleet's already installed avionics – an investment that results in a bias against modernization.

On the other hand, one seamless, capable, controlled 4DT NAS is the optimal construct for welcoming and integrating all newcomers into NAS.[12] The air traffic service provider bears the major burden of designing, building and implementing the 4DT equipment. Not only does the government rightfully pay for a National system that benefits everyone--not just aircraft operators, but the traveling and shipping public generally. But also, the FAA rightly has responsibility and control over safety certification and assurance of any new and innovative technologies incorporated into the 4DT ATC system, especially highly sophisticated automation. Aircraft operators, on the other hand, can equip with one suite of avionics, basically capable of transmitting operator intent, and receiving and executing ATC instructions. No need for sophisticated, expensive (if you can even get it) "self-separation" equipment, with the attendant certification, procedures, and safety assurance. Aircraft operator equipage for the NextGen NAS will be financially problematic enough under any circumstances[13], but expense on the operator side doubtlessly will be far less with the standardization possible under one seamless FAA-operated 4DT system, versus the complicated hybrid concept envisioned in con ops featuring segregated, self-separation airspace.

In conclusion, FAA must step up to the responsibility of designing and building one, fully capable, SEAMLESS, integrated 4DT NAS that welcomes everything—and everyone-- the future has to offer.

The authors:

[12] 4DT ATC automation has many technical advantages both over the legacy ATC system and proposed regimes based on self-separation. Not the least of these is its amenability to incorporation of automatic, system-knowledgeable tactical flight prioritization in circumstances in which operators are contending for the same routes, or points in space during times of traffic congestion. Much thinking and research already has been invested in 4DT, including coupling of 4TD ATC instructions for automatic execution through the aircraft FMS. *See*, e.g., Frisbie and Matthews, "To 4DT or not 4DT: Is there Really a Question?", Journal of Air Traffic Control, Fall 2021, https://www.safeaccess4uas.com/paper-to-4dt-or-not-4dt.html; Joint Planning and Development Office, "Trajectory Based Operations (TBO) Study Team Report," 2011, https://www.yumpu.com/en/document/read/26357339/trajectory-based-operations-tbo-joint-planning-and-; S. Ramasamy, R. Sabatini, A. Gardi, T. Kistan, "Next Generation Flight Management System for Real-Time Trajectory Based Operations," Applied Mechanics and Materials, vol. 629, pp.344-349, Trans Tech Publications, 2014. DOI: 10.4028/www.scientific.net/AMM.629.344; A. Gardi, S. Ramasamy, R. Sabatini and T. Kistan, "CNS+A Capabilities for the Integration of Unmanned Aircraft in Controlled Airspace," Proceedings of IEEE International Conference on Unmanned Aircraft Systems (ICUAS 2016). Arlington, VA (USA), June 2016. Print ISBN: 978-1-4673-9333-1.

[13] Frisbie and Matthews, "The second time around there ought to be a law…", Journal of Air Traffic Control, Spring 2020, https://www.safeaccess4uas.com/paper-avionics-equipage--second-time-around.html

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