On-Demand Aviation: Governance Challenges of Urban Air Mobility ("UAM")

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ABSTRACT

The first generation that has never known a world without smartphones and social media may be close to making the world forget about traditional cars. Investment is pouring into urban air mobility ("UAM")—the local, on-demand movement of people and goods by air using a range of piloted and semi- and fully autonomous electric aircraft that take off and land vertically. In fact, the innovation of aerial ridesharing at scale—a technology that is still very much associated with the 1960s cartoon series "The Jetsons"—may be at market as soon as 2025, according to some estimates.

UAM—which is also referred to as on-demand mobility ("ODM")—will revolutionize urban transportation and personal mobility, and impact matters from airspace management to aviation safety and property rights in unknown ways. For example, UAM will compete, supplement, and/or exist alongside traditional air and ground traffic operations, while in other cases, traditional transportation nodes such as airports might be intertwined and become a functional element of UAM systems themselves. To say that airports and the communities surrounding airports need to understand and anticipate the effects and opportunities of the UAM market is an understatement.

This Article addresses the emerging UAM market, including the relevant technologies from a legal and regulatory perspective. In conceptualizing a new world in which UAM is real, this Article will explore the various stages of legal, regulatory, and technological development of UAM. It also addresses practical questions such as how UAM and traditional transportation aviation operations might coexist in shared airspace and if and how communities will respond to environmental concerns such as UAM-generated noise. In all, this Article serves as a primer, presenting the substance and scope of UAM governance as presently configured, and where gaps exist (and many do), explores

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potential regulatory and socio-technological solutions to the challenges posed by advances in autonomous-, self-, and optionally-piloted aircraft systems.

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I. INTRODUCTION

"Imagine traveling from San Francisco's Marina to work in downtown San Jose—a drive that would normally occupy the better part of two hours—in only 15 minutes."[1] Or, "[w]hat if you could save nearly four hours round-trip between São Paulo's city center and the suburbs in Campinas?"[2] Or, "imagine reducing your 90-plus minute stop-and-go commute from Gurgaon to your office in central Delhi to a mere six minutes."[3] These enticing hypotheticals are set out at the beginning of a white paper Uber published in 2016 about the feasibility of air taxi operations and the concept of on-demand aviation. The animating idea of on-demand aviation is a network of small, two-to-nine passenger electric-powered aircraft that take off and land vertically, making possible rapid and regular air transportation between and within suburbs and cities.[4] Think flying cars.

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1. UBER ELEVATE, *Fast-Forwarding to a Future of On-Demand Urban Air Transportation*, UBER, Oct. 27, 2016, at 1, *available at* https://www.uber.com/elevate.pdf.

2. *Id*.

3. *Id*. While industry, academia, and government focus on the *minimization* of door-to-door trip time resulting from UAM, commercial airlines are testing the *maximum* endurance limits of human beings on ultralong flights made possible by new fuel-efficient jetliners (*i.e.*, New York to Sydney nonstop). *See, e.g.*, Mike Cherney, *Qantas to Test Human Endurance for a 19-Hour Flight*, WALL ST. J. (Aug. 22, 2019), https://on.wsj.com/2UZ5GwR (discussing Qantas Airways Ltd. plans to send wired-up employees on a 19-hour trip to see whether humans can keep up with technological advances. "Cabin passengers—mostly Qantas employees—also will don wearable devices. Scientists and medical experts from the University of Sydney will monitor sleep patterns, food and beverage consumption, lighting and human movement in the cabin during the test flights.").

4. UBER ELEVATE, *supra* note 1, at 1.

However futuristic the concept may sound, aerial ridesharing at scale may be at market sooner rather than later. As a 2018 publication by the American Institute of Aeronautics and Astronautics stated, "[a]viation technologies and concepts have reached a level of maturity that may soon enable an era of [on-demand mobility] fueled by quiet, efficient, and largely automated air taxis."[5] In fact, startup and established companies around the world, often with the substantial financial backing of venture capitalists, are researching, building, and testing "[a] network of small, electric aircraft that take off and land vertically, . . . [for the purpose of enabling] rapid, reliable transportation between suburbs and cities, and ultimately, within cities."[6] This new generation of piloted, semi-, and fully autonomous electric Vertical Takeoff and Landing ("eVTOL")[7] aircraft feature the latest advances in artificial intelligence, propulsion and other advanced technologies. Encouraged by the emergence of new paradigms for aviation traffic management, manufacturers of eVTOL aircraft envision a wide variety of use cases for the technology. These uses include on-demand air taxi operations moving people between fixed or *ad hoc* locations; air cargo operations moving goods between warehouses and stores; regularly scheduled "air metro" operations transporting passengers between a set of fixed locations; emergency medical evacuations, rescue operations, and humanitarian missions; law enforcement operations; newsgathering; weather monitoring; and ground traffic assessment.[8]

Altogether, the vision and concept of operations ("CONOPS") for on-demand aviation—an idea interchangeably referred to as on-demand mobility ("ODM") or urban air mobility ("UAM")—is about getting people and goods to their destinations more quickly than can be accomplished by cars today.[9] The viability of UAM lies in the fact that ODM imagines a node-based transportation system whose resiliency exceeds that of path-based transportation systems.[10] Indeed, "[j]ust as

5. Eric Mueller et al., *Enabling Airspace Integration for High-Density On-Demand Mobility Operations*, AM. INST. OF AERONAUTICS & ASTRONAUTICS, 2017, at 1, *available at* https://go.nasa.gov/3aJs5VA.

6. UBER ELEVATE, *supra* note 1, at 2.

7. Pronounced "e-vee-tol."

8. David P. Thipphavong et al., *Urban Air Mobility Airspace Integration Concepts and Considerations*, NASA TECH. REPORTS SERVER, 2018, at 7, *available at* https://go.nasa.gov/2UG80tu.

9. As researchers for NASA have noted, however, ODM is a broader term than UAM where "UAM is the subset of ODM that is focused on air traffic operations in metropolitan areas with aircraft capable of seating a small number of passengers or equivalent volume of goods flying trips of 100 nautical miles or less." *Id.* at 1–2. This Article uses the terms UAM and ODM to refer to aerial ridesharing in a metropolitan area, but the terms are also sometimes used to refer to a range different operations, including last mile, cargo, people, cargo and people, urban core, and eVTOL.

10. A node-based transportation system involves takeoff and landing areas whereas a path-based transportation system involves ground surface roads. *See* Thipphavong et al., *supra* note 8, at 5. *See also* Michael D. Patterson et al., *A Proposed Approach to Studying*

skyscrapers allowed cities to use limited land more efficiently," Uber has argued, "urban air transportation will use three-dimensional airspace to alleviate transportation congestion on the ground."[11] By rising above "the highly congested one-dimensional ground highway ant-trails, [companies in the UAM space such as Uber, through its "Uber Elevate" initiative, are working] to take advantage of three dimensions and create pathway-independent transportation solutions."[12] Ironically, in doing so, Uber is focused not merely on easing some of the traffic congestion and gridlock to which its operations contribute—an ironic state of affairs for a transportation network company ("TPN") that pioneered the sharing and services economy.[13] Indeed, Uber seems intent on upending and bypassing its own revolutionary car-based business by reimagining "heavy infrastructure" approaches involving roads, rail, bridges, and tunnels.[14] In this respect, UAM perhaps represents a natural and decisive next step in a national trend away from the automobile.[15]

Unlike an automobile, an air taxi would have "a unique ability to meet future on-demand services, as it is essentially unencumbered by ground-based limitations, along with the ability to achieve greater

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Urban Air Mobility Missions including and Initial Exploration of Mission Requirements, NASA TECH. REPORTS SERVER, 2018, at 1, *available at* https://go.nasa.gov/2whdQs4.

11. *See also* Kevin R. Antcliff et al., *Silicon Valley as an Early Adopter for On-Demand Civil VTOL Operations*, AMERICAN INST. OF AERONAUTICS & ASTRONAUTICS, 2016, at 1, available at https://go.nasa.gov/34aOUPm (identifying and evaluating the San Jose-San Francisco-Oakland area to evaluate the objective of minimizing door-to-door time for "Hyper Commuters" (frequent, long-distance commuters) in the Silicon Valley through the development of new helipad infrastructure for ultra-low noise VTOL aircraft).

12. *Id.* at 2; *see also Urban Air Mobility: Hearing Before U.S. House of Representatives Committee on Science, Space, & Technology*, 115th Cong. (2018) (testimony of Michael Thacker, Executive Vice President of Technology and Innovation, Bell), https://bit.ly/3cA5Zp5 [hereinafter Thacker Testimony] ("We believe the real solutions to the future of Urban Mobility lie not in the two-dimensional world of roads, buses, and other traditional options, but in new frameworks and partnerships based on multi-faceted ways of thinking about the possibilities.").

13. Eliot Brown, *The Ride-Hail Utopia Got Stuck in Traffic*, WALL ST. J., Feb. 15–16, 2020, at B1 (citing a 2019 study finding that over 60% of the slowdown of traffic speeds in San Francisco between 2010 and 2016 was due to the introduction of the ride-hail companies).

14. *See, e.g.*, Christopher Mims, *How Self-Driving Cars Could End Uber*, WALL ST. J. (May 7, 2017, 7:00 AM), https://on.wsj.com/3c2yNGi ("Uber's philosophy, both internally and in its pitch to consumers, is that it's a hassle to own a car. The irony is, for the pay-by-the-ride future of transportation to be realized, someone has to own a lot of cars. Chances are, it won't be Uber."). *See also* Graham Warwick, *Urban Renewal*, AVIATION WK. & SPACE TECH., Dec. 23, 2019–Jan. 12, 2020, at 97 ("Automotive manufacturers have been significant investors in UAM, led by Daimler, Toyota and China's Geely.").

15. *See, e.g.*, David Harrison, *America's Love Affair with Driving Takes a Back Seat*, WALL ST. J. (Dec. 24, 2019, 5:30 AM), https://on.wsj.com/2xmDdZT; Tim Higgins, *The End of Car Ownership*, WALL ST. J. (Jan. 20, 2017, 10:10 PM), https://on.wsj.com/34rU3mb; Christina Rogers & Gautham Nagesh, *Driving is Losing its Allure for Most Americans*, WALL ST. J. (Jan. 20, 2016, 5:30 AM), https://on.wsj.com/2UWmpls.

distribution and speed."[16] According to Uber, "millions of hours are wasted on the road worldwide" annually—the equivalent of commuting "seven whole working weeks" in a year in some cases.[17] According to a study published by the *American Journal of Preventative Medicine*, moreover, transportation congestion on the ground correlates with elevated blood pressure for commuters traveling more than 10 miles.[18] Given this, the idea of flying to-and-from work, or flying relatively short distances between any two points in the same city (*e.g.*, trips of 20 miles),[19] without the delays associated with traditional cars or scheduled commercial aviation service, is compelling. What is more, the principle selling point of on-demand aviation—recapturing productivity and leisure time lost while commuting—is not only conceptually appealing, but is also potentially widely available and affordable to the general public.[20]

In addition to convenience, UAM offers the benefit of requiring relatively little ground infrastructure. Indeed, UAM operations project to be implemented more quickly and at a lower cost compared to other ground-based modes. Instead of extensive roads, overpasses, bridges, tracks, and right-of-ways, the primary physical infrastructure UAM need are vertiports that have relatively small footprints.[21] Specifically, vertiports can be built on top of buildings, parking structures, floating barges, or in roadway cloverleaves re-purposed with raised helipad structures.[22] This may result in smaller capital expenditures to integrate UAM into metropolitan areas and more rapid expansion of connectivity between existing areas or into new areas, compared to ground-based modes.[23]

No wonder, then, that interest in UAM is bourgeoning in both private and public spheres. Interested parties include gig economy innovators like Uber, aerospace giants like Airbus, and new startups like Terrafugia, together with government agencies like the National Aeronautics and

16. Kevin R. Antcliff et al., *supra* note 11, at 1.

17. UBER ELEVATE, *supra* note 1, at 2.

18. *See, e.g.*, Christine M. Hoehner et al., *Commuting Distance, Cardiorespiratory Fitness, and Metabolic Risk*, 42 AM. J. OF PREVENTATIVE MED. 571, 575 (2012) ("Commuting distance was negatively associated with physical activity and CRF and positively associated with BMI, waist circumference, systolic and diastolic blood pressure, and continuous metabolic score in fully adjusted linear regression models.").

19. *See* U.S. DEP'T OF TRANSP., BUREAU OF TRANSP. STAT., FINDINGS FROM THE NATIONAL HOUSEHOLD TRAVEL SURVEY: LONG DISTANCE TRANSPORTATION PATTERNS (2006), *available at* https://bit.ly/3b1XL8y.

20. *See* UBER ELEVATE, *supra* note 1.

21. *See id*. at 51–52.

22. *See id.*

23. *See* Thipphavong et al., *supra* note 8, at 5 ("On the other hand, if most UAM aircraft are electrically-powered, UAM could add significant electrical infrastructure requirements for electrical power generation and transmission. Fortunately, it is expected that the electrical infrastructure will be expanded anyway to support the anticipated growth in the number of ground vehicles with electric powertrains.").

Space Administration ("NASA") and European Union Aviation Safety Agency ("EASA"). Both private and public entities have invested significant attention to cultivating a collaborative ecosystem among regulators and regulated actors, including eVTOL manufacturers, builders of takeoff and landing areas, and researchers of the airspace integration concepts, technologies, and procedures needed to conduct UAM safely and efficiently alongside other airspace users.[24] As a result, some eVTOL manufacturers are now manufacturing prototypes and testing ODM CONOPS, including Airbus in Brazil,[25] Kitty Hawk in New Zealand,[26] and Volocopter in the United Arab Emirates.[27]

Accepting the idea that high-tempo, high-density UAM operations could one day be as routine and reliable as traditional airline travel is today, this Article addresses the emerging UAM market, including the relevant technologies, from a legal, regulatory, and policy perspective. In imagining and conceptualizing a new world in which UAM is real, this Article explores and critiques the various stages of legal, regulatory, and technological development of UAM. Part II details UAM aircraft and operations and establishes background for understanding ODM. Part III then sets out the legal and regulatory barriers for UAM, including issues of jurisdiction, safety and security, airspace integration, and community acceptance. Finally, Part IV, drawing from lessons learned from the rulemaking process associated with unmanned aerial systems—"UASs" or "drones"—presents and analyzes normative and policy-related questions, arguing in favor a legal and regulatory environment that encourages development of UAM. Ultimately, this Article presents the substance and scope of existing UAM governance, and where gaps exist (and many do), addresses regulatory and socio-technological solutions that may solve challenges posed by advances in autonomous and optionally-piloted aircraft systems.

II. BACKGROUND

UAM operations are likely to emerge in three phases. First, so-called emergent UAM operations will be characterized by low-tempo, low-density flights along a small set of fixed routes between a few takeoff and landing areas ("TOLAs").[28] The aircraft serving these operations will likely be piloted by professional airmen, and eventually, fully automated

24. *See id.*

25. *See* Jeffrey Lewis & Luciana Magalhaes, *Here Come Helicopters on Demand*, WALL ST. J. (June 20, 2017), https://on.wsj.com/2UXnqsp.

26. *See* Andrew Ross Sorkin, *Larry Page's Flying Taxis, Now Existing Stealth Mode*, N.Y. TIMES (Mar. 12, 2018), https://nyti.ms/2xI5Osy.

27. *See* Mariella Moon, *Dubai Tests a Passenger Drone for Its Flying Taxi Service*, ENDGADGET (Sept. 26, 2017), https://engt.co/2w9YRA0.

28. *See* Thipphavong et al., *supra* note 8, at 3.

aircraft capable of high-density ODM operations.[29] Early expanded UAM operations represent a second phase, characterized by higher-tempo, higher-density flights in a small network of vertiports (or "vertistops") feeding a common hub location and managed by UAM operator and third-party services.[30] Finally, mature UAM operations would feature high-tempo, high-density flights in a network with multiple hub locations, potentially with orders-of-magnitude more vehicles and operations in an area than are currently supported in the national airspace system ("NAS").[31]

Interestingly, whether or not UAM operations evolve along this predicted continuum, from emergent to mature, the operation of numerous and frequent air traffic operations within metropolitan areas is not unprecedented. Commercial UAM operations began in the United States in the 1940s with the operation of helicopters.[32] Between 1947 and 1971, Los Angeles Airways connected passengers and mail between dozens of locations in the Los Angeles Basin, including Disneyland and Los Angeles International Airport.[33] During the same time period, New York Airways flew passengers between heliports in Manhattan and the region's three airports—LaGuardia, JFK, and Newark.[34] In 1968, however, Los Angeles Airways ceased operations after mechanical failures caused two separate fatal accidents.[35] New York Airways stopped flying almost a decade later, in 1977, also after several mechanical failures caused the deaths and injuries of dozens of passengers, crew members, and bystanders at heliports.[36] Technological advances have rejuvenated both interest and confidence in the concept of connecting urban destinations by air, however.[37]

Two advances in particular—distributed electric propulsion ("DEP") and autonomous operation technologies—differentiate the aircraft envisaged in future UAM operations from the on-demand helicopter operations decades ago. In fact, A^3/Airbus's Vahana concept,[38] eVolo's

29. *See id.*

30. *See id.*

31. *See id.*

32. *See id.*; *see also* Brian Garrett-Glaser, *Skyryse Unveils Autonomous Helicopter for Urban Air Mobility, Targets Economics of Commuter Cars*, AVIONICS INT'L (Dec. 17, 2019), https://bit.ly/2UXh6Bg; Saulo B. Cwerner, *Vertical Flight and Urban Mobilities: The Promise and Reality of Helicopter Travel*, 1 MOBILITIES 191 (2006).

33. *See* Thipphavong et al., *supra* note 8, at 2.

34. *See id.*

35. *See* Scott Harrison, *From the Archives: Los Angeles Airways Helicopter Overturns*, L.A. TIMES (Mar. 10, 2017), https://lat.ms/2Jy8RX0.

36. *See* Thipphavong et al., *supra* note 8, at 2; *see also* Richard Witkin, *New York Airways Acts to File for Bankruptcy*, N.Y. TIMES (May 16, 1979), https://nyti.ms/3e1Nawy.

37. *But see* Bill Chappell, *What We Know: The Helicopter Crash that Killed Kobe Bryant and 8 Others*, NPR (Jan. 27, 2020), https://n.pr/3aF4wNr.

38. *See Vahana*, AIRBUS, https://bit.ly/2RvqkDT (last visited May 20, 2020).

18-prop Volocopter,[39] and eHang's 184 quad/octocopter[40] are platforms that, in important ways, are unlike helicopters. As Uber has explained:

> VTOL operations will involve the ability to take off with a rapid climb at a steep glide path angle to reach a cruising altitude up to a few thousand feet, then decelerate to land vertically at the end of the trip. There will likely be a limited need to hover for durations not exceeding one minute, with most vertical takeoff and landing transitions taking place in approximately 30 seconds. Helicopters, on the other hand, are designed for military and multi-use roles that require sustained hovering for extended time (search and rescue, powerline inspection, takeoff and landing at unprepared locations, etc.). Hence helicopters are currently designed to optimize for hover efficiency, rather than for cruise. VTOLs will spend far more time in cruise which raises the question of how to optimize such a vehicle across short-term hover power versus long-term cruise energy.[41]

Thus, VTOL technology, augmented by DEP and automation, offers the potential to overcome four primary barriers to commercial aerial ridesharing: safety, noise, emissions, and vehicle performance.[42]

Given the promise of these technological advances, more than 200 companies are currently developing and manufacturing DEP and VTOL concepts; among the firms involved are Aurora (Boeing subsidiary),[43] Astro,[44] Bell,[45] Cora,[46] Joby Aviation,[47] Lilium,[48] Moog,[49] Porsche,[50] Skypod Aerospace Corp.,[51] Uber Elevate,[52] VRCO,[53] Xwing, [54] and

39. *See* VOLOCOPTER, https://bit.ly/2XsUnzB (last visited May 20, 2020).
40. *See Passenger Transportation*, EHANG, https://bit.ly/39Yf6OG (last visited May 20, 2020).
41. UBER ELEVATE, *supra* note 1, at 35.
42. *See id*. at 14.
43. *See* AURORA FLIGHT SCIENCES, https://bit.ly/2VkLntH (last visited May 20, 2020).
44. *See* ASTRO, https://bit.ly/2xaOdd1 (last visited April 2, 2020).
45. *See* BELL TEXTRON INC., https://bit.ly/2Xp19q7 (last visited May 20, 2020).
46. *See* WISK AERO LLC, https://bit.ly/2y1HMZQ (last visited May 20, 2020).
47. *See* JOBY AVIATION, https://bit.ly/3c2BibE (last visited May 20, 2020).
48. *See* LILIUM, https://bit.ly/39WQC8b (last visited May 20, 2020).
49. *See* MOOG INC., https://bit.ly/2y3hTbW (last visited May 20, 2020).
50. *See* Press Release, Boeing, Porsche and Boeing to Partner on Premium Urban Air Mobility Market (Oct. 10, 2019) https://bit.ly/3ee7PNO.
51. *See* SKYPOD AEROSPACE CORP., https://bit.ly/34tAqub (last visited May 20, 2020).
52. *See* Andrew G. Simpson, *Look! Up in the Sky. Uber and Hyundai Unveil Air Taxi*, INS. J. (Jan. 7, 2020), https://bit.ly/2XuRE8X (reporting that Uber and Hyundai Motor Co. announced they will develop Uber Air Taxis for a future aerial ride share network). The companies unveiled a new full-scale aircraft concept at the Consumer Electronics Show (CES) in Las Vegas. *See id*.
53. *See* VRCO LTD., https://bit.ly/2UZPYCF (last visited Apr. 3, 2020).
54. *See* XWING, https://bit.ly/2y8CYC0 (last visited May 20, 2020).

Zee.Aero (Google).[55] The ODM aircraft these and other firms are developing typically fall into one of two configuration types: (1) large multicopters classified by the Federal Aviation Administration ("FAA") as rotorcraft because lift during all phases of flight is generated by powered propellers or rotors; or (2) aircraft that use powered-lift (*e.g.*, tilt-rotors or -wings) for takeoff and landing but transition to wing-borne flight during cruise.[56]

While the ODM designs that are best suited or preferred for particular types of missions and metropolitan areas remain to be seen,[57] what a UAM trip might look like is easier to imagine. As a report by the American Institute of Aeronautics and Astronautics states:

> "[H]igh-density" operations . . . would consist of approximately 1200 aircraft operating simultaneously over a large metropolitan area (*e.g.*, the San Francisco Bay area, New York City, the Dallas-Fort Worth metro area). This fleet size equates to approximately one aircraft per nmi, compared with typical maximum enroute traffic densities of about one aircraft per 250 to 500 nmi (densities increase significantly near airports, but are still far lower than this ODM reference scenario).
>
> Such a fleet might average four trips per hour, each carrying two passengers, over a 16-hour day. This scenario could support approximately 150,000 passengers per day, which would make it an important travel mode alternative to ground transportation, but it would still represent a very small proportion of the overall transportation options available to the public (about 2% of the automobile trips taken in the San Francisco Bay area per day).[58]

Amazingly, UAM manufacturers and operators have identified and even resolved many of the operational issues associated ODM activities. As Michael Thacker, Executive Vice President for Technology and Innovation at Bell, testified before the House of Representative's Science, Space, and Technology Committee:

> Beyond the environment driving vehicle and operating requirements, there are myriad operating details to consider, including vertiport locations, charging stations, ground safety protocols, secure passenger identification and access, and more. We also cannot ignore normal aviation operational requirements for vehicle identification,

55. *See* Ashlee Vance & Brad Stone, *Welcome to Larry Page's Secret Flying-Car Factories*, BLOOMBERG (June 9, 2016), https://bloom.bg/3e6KHkt.

56. *See* Mueller et al., *supra* note 5, at 3 (discussing "[a] third category, conventional take-off and landing (CTOL) aircraft, are most often used in an ODM context for flying hundreds of miles between airports that are underserved by scheduled commercial operations. Because these flights inherently traverse less-used airspace they do not face the same airspace integration concerns of the first two aircraft categories").

57. *See* Thipphavong et al., *supra* note 8, at 7–8.

58. Mueller et al., *supra* note 5, at 3.

> communication and separation in a potentially more constrained airspace, or standard requirements and practices for maintenance, inspections and continued airworthiness.
>
> Most, if not all, of these operational challenges have been addressed in some form in existing aircraft operations. We obviously already operate helicopters in many urban locations today. The system gaps come due to potential increases in traffic volume, particularly in low altitude airspace, and the increasing use of automation to enhance operational safety and efficiency.[59]

In other words, for flying on-demand or scheduled air taxi operations to become regular and reliable, several technical challenges must be overcome. But, that may just be a factor of time. The greatest challenge may lie in the fact that lawmakers must fill regulatory gaps and dispel popular associations of UAM with the make-believe flying cars of the 1960s cartoon series "The Jetsons."

III. LEGAL AND REGULATORY BARRIERS

UAM will revolutionize personal mobility and impact traditional transportation modalities in innumerable ways. Although some rules of the road exist, UAM may require altogether new rules. For example, Part 14 of the Code of Federal Regulations establishes detailed rules for the operation of aircraft with an onboard pilot.[60] But, for remotely piloted and autonomous UAM operations to become regular and reliable, lawmakers will need to modify rules currently applicable to drones, or else develop new regulations addressing, *inter alia*, the following types of activities and missions:[61]

- Beyond visual line of sight operations, which are currently addressed only through a waiver process under 14 C.F.R. § 107.31;
- Operations over people, streets, etc., which are currently addressed only through a waiver process under 14 C.F.R. § 107.39;
- The commercial carriage of air cargo across state lines;
- Air ambulance activities, *e.g.*, when a passenger or patient is being transported in a UAM either within visual line of sight or beyond;
- Flight in instrument conditions;

59. *See also* Thacker Testimony, *supra* note 12.
60. *See* 14 C.F.R. §§ 21, 23, 25, 27, 36, 61, 91, 119 (2019).
61. BOOZ ALLEN HAMILTON, URBAN AIR MOBILITY (UAM) MARKET STUDY 20–21 (2018), *available at* https://go.nasa.gov/2Js4Nr6.

- Airworthiness certification of remotely piloted and autonomous aircraft; and
- Training and knowledge requirements for pilots and operators.

Additionally, ODM will require lawmakers outside of the aviation regulatory framework to address general concerns such as airspace management and property rights, environmental matters, privacy, and safety. The success of UAM, therefore, seems (at least initially) to turn on the resolution of these legal issues. But, as a report by the MITRE Corporation put it, "[j]udging from the scale of the investments, number of proponents, progress to date, and the current state of technology development in the UAS industry . . . it is not a matter of if UAM will happen but a matter of how quickly regulatory environments and operations policies" can change, enabling full-scale operations.[62] This next section details the most significant potential legal obstacles to UAM, namely issues of federalism, preemption, airspace, and community acceptance.

A. Federalism

UAM flights will occur exclusively within state or local jurisdictions. Indeed, all the various definitions of UAM revolve around a common idea that envisions an airplane of some kind serving *inter*-city and *intra*-city routes between local TOLAs within 20 miles of each other. But UAM operations invariably will impact stakeholders and interests beyond city and state borders. For example, federal interests will be implicated as eVTOL aircraft fly in the *national* airspace (*i.e.*, 500 feet above the ground).[63] As such, and as with other areas of law and emerging technologies, courts will be called on to resolve a "tug of war" between federal and state/local authority as each government vies for the power to regulate UAM.[64] Identifying the lead regulatory authority among local, state, and federal regulators is thus a primary legal and regulatory challenge that must be addressed to bring UAM transportation to market.

As a starting point, states wield significant lawmaking powers. While federal law is the "supreme Law of the lLand," states, pursuant to the Tenth Amendment of the Constitution, possess unenumerated rights and powers "not delegated to the United States."[65] For example, although

62. BROCK LASCARA ET AL., URBAN AIR MOBILITY LANDSCAPE REPORT 6 (Mitre Corp., 2018), *available at* https://bit.ly/3avKyVf ("Judging from the scale of the investments, number of proponents, progress to date, and the current state of technology development in the UAS industry, we believe it is not a matter of if UAM will happen but a matter of how quickly regulatory environments and operations policies can adapt to permit full-scale operations.").

63. *See infra* Section III.B.

64. *See* HAMILTON, *supra* note 61, at 20–21.

65. U.S. CONST. amend X.

courts have ruled that states have no authority to regulate the prices, routes, and services of airlines under the Airline Deregulation Act of 1978,[66] state and local lawmakers (alone or in tandem with federal authorities) have long governed other aviation issues, ranging from airport licensing and funding to aircraft registration and recordation to land use and zoning.[67] Judges, too, have established a substantial body of state and federal law concerning airports,[68] aviation infrastructure and environment,[69] airplane accidents,[70] remedies,[71] and torts including aircraft product liability suits.[72] Moreover, pursuant to their police powers to promote the health, safety, and welfare of their inhabitants, state and local officials routinely enact and prosecute criminal and civil laws such as negligence, trespass, nuisance, and invasions of privacy arising from aviation activities. The laws of different states sometimes conflict, however, and the issue of whether or how to harmonize the laws of several states within the nation's constitutional framework has come before courts.

The case of *Northwest Airlines, Inc. v. Minnesota* is an early example.[73] At issue was the constitutionality of a state tax codified in the 1930s. Minnesota enacted and assessed a general *ad valorem* property tax upon "all personal property of persons residing therein, including the property of corporations."[74] The airline based its personal property tax return on the number of its planes in Minnesota.[75] The state of Minnesota assessed the tax against the airline more broadly, however. It computed "taxes on the basis of the [airline's] entire fleet coming into Minnesota" from other states.[76] The United States Supreme Court evaluated how

66. *See* Airline Deregulation Act of 1978, 49 U.S.C. § 41713 (2018).

67. *See, e.g.*, FLA. STAT. ANN. § 330.30 (2005) (a 1947 law requiring state approval of airport registration, licensure, and site selection).

68. *See, e.g.*, Int'l Soc'y for Krishna Consciousness, Inc. v. Lee, 505 U.S. 672, 683 (1992) (noting Port Authority's regulation forbidding certain speech in airport terminals did not violate the First Amendment).

69. *See, e.g.*, Goodspeed Airport, LLC v. E. Haddam Inland Wetlands & Watercourses Comm'n, 681 F. Supp. 2d 182, 206, 210 (D. Conn. 2010) (ruling that federal aviation safety regulations did not preempt generally applicable state and local environmental laws).

70. *See, e.g.*, Vreeland v. Ferrer, 71 So. 3d 70, 84 (Fla. 2011) (finding that Congress did not preempt Florida's dangerous instrumentality doctrine where aviation fatality did not occur "on the surface of the earth").

71. *See, e.g.*, Abdullah v. Am. Airlines, Inc., 181 F.3d 363, 375 (3d Cir. 1999) (holding that federal law preempted state or territorial standards of care relating to aviation safety, but not traditional state and territorial remedies that apply to the violation of those standards).

72. *See, e.g.*, Sikkelee v. Precision Airmotive Corp., 822 F.3d 680, 709 (3d Cir. 2016) (ruling that federal preemption in the field of aviation safety did not extend to state products liability claims).

73. *See* Nw. Airlines, Inc. v. Minnesota, 322 U.S. 292 (1944).

74. *Id.* at 294 (quoting MINN. STAT. § 272.01 (1941)).

75. *See id.* at 293.

76. *Id.*

Minnesota's taxation impacted interstate commerce and, more particularly, "whether the Commerce Clause or Due Process Clause of the Fourteenth Amendment barred Minnesota from enforcing the personal property tax it [levied] on the entire fleet of airplanes owned . . . and operated by [Northwest Airlines] in interstate transportation."[77]

A majority of the Court upheld the state's taxing power, finding that it did not run afoul of the Constitution. The Court reasoned that the Minnesota tax was not a tax "for engaging in interstate commerce or upon airlines specifically."[78] The court also reasoned that the tax was neither aimed at nor measured by interstate commerce.[79] Finally, the tax was not assessed against airplanes continually outside of Minnesota during the relevant tax year.[80]

More remarkable than these legal conclusions were the context in which the case arose and the rationale underlying the court's holding. The Minnesota statute in *Northwest Airlines, Inc.* presented a novel context—air transportation—in which to referee the relations between and among states. To approach the unprecedented issues before it, the Court relied on and extended laws and policies applicable to other transportation modalities—especially steamships—to the then-revolutionary reality of commercial airplanes flying regularly above and across state lines.[81]

To illustrate, the Court noted that air commerce at the time of *Northwest Airlines, Inc.*—the mid-1940s—was at an early stage in development, roughly comparable to that of steamship navigation in the 1820s.[82] Vessels, the Court recognized, were taxable only at their domicile or home ports under the "home port theory."[83] Given that Northwest Airlines was incorporated and based in the state of Minnesota,[84] the Court analogized commercial airplanes with steamship vessels, and found that Minnesota was the home port for the airline's aircraft.[85] In doing so, the Court applied established ideas of state sovereignty and tax jurisdiction to a new dimension—the airspace above cities, states, and the nation.

Notably, the Court recognized that its holding—obtained by analogizing the two-dimensional operation of vessels to the three-dimensional operation of airplanes—was imperfect.[86] But the Court also recognized that the law was destined to trail behind innovation and that

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77. *Id.* at 292.
78. *Id.* at 294.
79. *See id.*
80. *See id.*
81. *See id.*
82. *See id.* at 302 (Jackson, J., concurring).
83. *The Home Port Doctrine Held Applicable to Foreign Air Commerce*, 23 OHIO ST. L.J. 561, 562 (1962); *see also* Hays v. Pac. Mail S.S. Co., 58 U.S. 596, 599 (1854).
84. *See* Nw. Airlines, Inc. v. Minnesota, 322 U.S. 292, 292 (1944).
85. *See id*. at 294–95.
86. *See id*. at 300.

new technologies would always require legal philosophies to catch up, particularly in terms of innovations in mobility and travel.[87] Indeed, *Northwest Airlines, Inc.* centered on the narrow issue of applying the doctrine of tax apportion among states in matters of air commerce. But *Northwest Airlines, Inc.'s* importance for UAM firms may lie in what it says about how courts approach the difficult issue of mediating the laws of 50 states and of the federal government—especially where a uniform approach to emerging technologies is undesirable or unrealistic.

Just as Minnesota acted in its own self-interest in *Northwest Airlines, Inc.* so too are states and municipalities likely to codify UAM rules that express local solutions to local concerns—just as they are in the context of other disruptive aviation technologies.[88] In doing so, such laws may potentially conflict with the laws of other jurisdictions. Judicial restraint is optimal in that circumstance, as Justice Frankfurter explained in *Northwest Airlines, Inc.*:

> The doctrine of tax apportionment has been painfully evolved in working out the financial relations between the States and interstate transportation and communication conducted on land and thereby forming a part of the organic life of these States. Although a part of the taxing systems of this country, the rule of apportionment is beset with friction, waste and difficulties, but at all events it grew out of, and has established itself in regard to land commerce. To what extent it should be carried over to the totally new problems presented by the very different modes of transportation and communication that the airplane and the radio have already introduced, let alone the still more subtle and complicated technological facilities that are on the horizon, raises questions that we ought not to anticipate; *certainly we ought not to embarrass the future by judicial answers which at best can deal only in a truncated way with problems sufficiently difficult even for legislative statesmanship*.
>
> *Each new means of interstate transportation and communication has engendered controversy regarding the taxing powers of the States inter se and as between the States and the Federal Government. Such controversies and some conflict and confusion are inevitable under a federal system*.[89]

In this context, like ships, railroad rolling stock, the radio, and even commercial airliners before it, UAM portends a new era of controversies centered on the concept of federalism—the constitutional relationship between the 50 state governments and the national federal government.

87. *See id*.

88. *See generally* Margot E. Kaminski, *Drone Federalism: Civilian Drones and the Things They Carry*, 4 CAL. L. REV. CIR. 57 (2013) (advocating for a state-based approach to privacy regulation that governs drone use by civilians).

89. *Id.* at 300 (emphasis added).

While the precise nature of the relationship among local, state, and federal authorities relative to UAM is unclear at this point, it is likely to have a distinctly national flavor.

The role of the federal government in aviation matters since the 1940s has grown exponentially. Justice Jackson's concurrence in *Northwest Airlines, Inc.* anticipated as much. Though he agreed with the majority's support for a state's taxing authority (in the absence of a better analogy than the home port theory traditionally applied to ships), he also recognized a trend in the law—an emerging and near-total divestment of state power over air space and air commerce as a matter of law:

> Aviation has added a new dimension to travel and to our ideas. The ancient idea that landlordism and sovereignty extend from the center of the world to the periphery of the universe has been modified. Today the landowner no more possesses a vertical control of all the air above him than a shore owner possesses horizontal control of all the sea before him. The air is too precious as an open highway to permit it to be "owned" to the exclusion or embarrassment of air navigation by surface landlords who could put it to little real use.
>
> Students of our legal evolution know how this Court interpreted the Commerce Clause of the Constitution to lift navigable waters of the United States out of local controls and into the domain of federal control. Air as an element in which to navigate is even more inevitably federalized by the commerce clause than is navigable water. Local exactions and barriers to free transit in the air would neutralize its indifference to space and its conquest of time.[90]

In fact, in the more than 75 years since the Supreme Court rendered its opinion in *Northwest Airlines, Inc.*, federal law has become pervasive in aviation matters, ranging from airport funding and security to airline safety and passenger rights.[91] Room for the exercise of state and local government power in the UAM space appears minimal in this context. Yet, for local UAM operations to take flight, state and local lawmakers must be integrally involved in the regulatory space and a high degree of cooperation between the FAA and state, local, and tribal governments must occur.

B. Preemption

In general, federal, state, and local authorities govern independently of (or concurrently with) each other consistent with the principles of federalism enshrined in the Constitution. But State or local laws sometimes conflict with federal law. Similarly, local ordinances may clash

90. *Id*. at 302.
91. *See id*. at 303.

with statutes enacted at the state level.[92] In such cases, courts are often asked to resolve questions of preemption, *i.e.*, whether federal law entirely divests and displaces state and local law or whether state and local laws can coexist alongside federal law. The doctrine of preemption poses a particular challenge for innovators and consumers of disruptive technologies such as UAM because, notwithstanding the local character of air taxi operations, ODM implicates state- and nation-wide interests. Local, state, and federal UAM regulatory initiatives inevitably conflict, not merely overlap.

Among the most pressing preemption-related questions (existing or anticipated) for UAM firms are, for example:

- Into which government authority—local, state, national, or international—should the power to manage airspace for UAM operations vest?
- Who, among local, state, or federal authorities, should regulate property issues related to UAM operations, including the vertiports from which UAM eVTOL will take-off and land?
- How will responsibility for issues such as safety, security, privacy, nuisance, and trespass be shared among local, state, and federal regulators? Should they be shared?
- Within what jurisdiction—local, state, or federal—will issues such as ODM passenger and contract rights fall?

Scant precedent from traditional manned aviation law exists for UAM firms to answer these questions directly or by analogy. In civil aviation matters,[93] for example, many of the nation's largest airports draw funding from federal sources though they are managed by airport authorities that are arms of the localities in which they are situated. Such a scheme may not make sense in the UAM space, however, given that TOLAs will be situated within the boundaries of, and likely managed exclusively by one city for strictly intra-city flights. Thus, even though federal aviation regulators may have an interest in harmonizing all ODM rules, they will need to account for the local nature of ODM operations. By analogy, although every city has stop signs and red lights for vehicular traffic, placement of those signals is dictated by local concerns. So, too, might

92. The power of a state to preempt and subordinate local law—referred to as Dillon's Rule—derives from an interpretation of a local government's authority in which a local or municipal government (i.e., a "substate") may engage in an activity only if it is specifically sanctioned by the state government. *See* NAT'L LEAGUE OF CITIES, *Local Government Authority*, https://bit.ly/2xHzw0C (last visited May 20, 2020); *see also* JOHN F. DILLON, COMMENTARIES ON THE LAW OF MUNICIPAL CORPORATIONS 448 (5th ed. 1911).

93. *See* Charles S. Rhyne, *Federal, State and Local Jurisdiction Over Civil Aviation*, 11 L. & CONTEMP. PROBS. 459 (1946).

federal rules for ODM have to accommodate rather than preempt local realities.

Although how the doctrine of preemption will play out in the UAM space is unclear, a comparison of the legal and regulatory challenges for UAM with those of *unmanned* aerial systems—"UAS" or "drones"—may be helpful in the near term, if for no other reason than to emphasize that federal, state, and local governments will need to achieve greater and perhaps unique levels of cooperation if UAM ideas are to succeed. The case of *Singer v. City of Newton* is a leading example.[94] At issue in *Singer* was whether an ordinance enacted by the City of Newton, Massachusetts to safeguard local privacy complied with federal aviation regulations relating to UAS. By its own terms, the purpose of the ordinance was to strike a balance between encouraging innovation and the use of pilotless aircraft while also reasonably safeguarding the public:

> It is important to allow beneficial uses of these devices while also protecting the privacy of residents throughout the City. In order to prevent nuisances and other disturbances of the enjoyment of both public and private space, regulation of pilotless aircraft is required. The following section is intended to promote the public safety and welfare of the City and its residents. In furtherance of its stated purpose, this section is intended to be read and interpreted in harmony with all relevant rules and regulations of the Federal Aviation Administration, and any other federal, state and local laws and regulations.[95]

In this context, the ordinance specifically: (1) required the registration of all drones; (2) prohibited pilotless aircraft flight below 400 feet over any private property without the express written permission of the property owner; (3) prohibited pilotless aircraft flight over public property with prior permission from the city; and (4) banned the flight of pilotless aircraft "at a distance beyond the visual line of sight of the Operator."[96] The plaintiff challenged subsections of the ordinance relating to drone registration and operation.[97] He argued that the ordinance was preempted by federal law because it attempted to regulate—and, therefore, conflicted with—an almost exclusively federal area of law, *i.e.*, the regulation of airspace.[98] In contrast, the city asserted that the ordinance was not preempted by federal law because it fell within an area of law that the FAA

94. *See generally* Singer v. City of Newton, 284 F.Supp.3d 125 (D. Mass. 2017). The case was appealed to the First Circuit Court of Appeals, but then voluntarily dismissed. *See* Singer v. City of Newton, No. 17–2045, 2017 WL 8942575, at *1 (1st Cir. Dec. 7, 2017).
95. *Singer*, 284 F.Supp.3d at 128 (2017).
96. *See id.* at 128.
97. *See id.*
98. *See id.*

expressly carved out for local governments to regulate, and thus could be read in harmony with federal aviation laws and regulations.[99]

The court struck down the ordinance under the doctrine of conflict preemption.[100] The city's choice to restrict drone use below 400 feet worked to eliminate any drone use in the confines of the city, absent prior permission, the court stated.[101] This ordinance thwarted not only the FAA's objectives, but also those of Congress for the FAA to integrate drones into the national airspace.[102] Moreover, the court concluded that although Congress and the FAA may have contemplated co-regulation of drones to a certain extent, this hardly permitted an interpretation that essentially constituted a wholesale ban on drone use in Newton.[103]

Since the court's ruling in 2017, many UAS industry observers have characterized *Singer* as a leading case of first impression with respect to emerging innovations in unmanned aviation.[104] More specifically, UAS and UAM industry analysts have recognized *Singer* as leaving little to no space for state and local authorities to regulate the airspace within their geographical jurisdiction:

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99. *See id.*

100. The United States Supreme Court has established a general framework and taxonomy that recognizes three different types of preemption: "express" preemption, "implied" (field) preemption, and "conflict" preemption. First, federal laws are said to preempt state law or local ordinances where the federal government occupies a field. To determine the extent of federal authority in an area, courts recognize two types of preemption, express and implied. Express preemption exists when the language of a federal law communicates an explicit intent by Congress to preempt state law. Whether a federal law preempts a state law is a question of congressional intent. Thus, if Congress intended to govern an issue exclusively it need only say so and the law will be recognized as the supreme law of the land pursuant to the Supremacy Clause of the Constitution. *See* U.S. CONST. art. VI, cl. 2. Or, as Chief Justice Marshall wrote, "in every case, the act of Congress, or the treaty, is supreme; and the law of the state, though enacted in the exercise of powers not controverted, must yield to it." Gibbons v. Ogden, 22 U.S. (9 Wheat.) 1 (1824). More often than not, however, federal laws are not express or unambiguous and courts must determine the intent of Congress, i.e., implied preemption.

Implied preemption consists of two subcomponents, "conflict preemption" and "field preemption." Conflict preemption is said to exist either when compliance with both the federal and state laws is a "physical impossibility," or when the state law stands as an "obstacle" to the accomplishment and execution of the full purposes and objectives of Congress. Courts have found that the latter exists when a court determines that a federal regulatory scheme is so pervasive that Congress must have intended to leave no room for a state to supplement it. Courts generally understand field preemption to mean that federal law "thoroughly occupies" the "legislative field" in question, e.g., the field of aviation safety. Field preemption analysis frequently comes up in the arena of aviation safety; courts have found that safety-related issues such as aircraft certification typically fall within the exclusive province of the federal government.

101. *See Singer*, 284 F.Supp.3d at 128.

102. *See id*.

103. *See id*.

104. *See also* John Goglia, *What's the Status of Local Drone Ordinances after the Singer Decision?*, FORBES (Sept. 25, 2017), https://bit.ly/2R8Nsrw.

> [W]hen it comes to certain UAS operations[,] . . . federal law preempts local regulations. A city cannot regulate flight operations, and it may not effectively ban drone flights against the express congressional intent to encourage drone use. Even though the ordinance intended to protect the city citizens' privacy, portions of it extended into the FAA's operational safety and licensing authority and was struck down.[105]

In this regard, *Singer* foreshadows potential preemption problems for UAM manufacturers, owners, and operators, and puts a premium on cooperation among authorities at various layers of government even for putatively local activities. In fact, among the states that have proposed or enacted UAS-related laws—laws that may serve as a precursor to similar UAM operations—many have explicitly relinquished or rendered inferior their authority relative to that of the federal government.[106] For example, Connecticut, Maryland, and Virginia state laws prohibit municipalities from regulating UASs.[107] Meanwhile, a law proposed in Arizona would prohibit the operation of a model aircraft or civil unmanned aircraft "if the operation is prohibited by a federal law or regulation that governs aeronautics."[108] The law would have materially constrained local lawmaking powers relative to drones, too:

> Except as authorized by law, a political subdivision of this state may not enact or adopt any ordinance, policy or rule that relates to the ownership or operation of an unmanned aircraft, an unmanned aircraft system, a civil unmanned aircraft or a public unmanned aircraft or otherwise in engage in the regulation of the ownership or operation of an unmanned aircraft, an unmanned aircraft system, a civil unmanned aircraft or a public unmanned aircraft if the ordinance, policy or rule is more prohibitive than or has a penalty that is greater than any state law penalty, whether enacted or adopted before or after the effective date of this section.[109]

Similarly, lawmakers in Florida proposed an "Unmanned Aircraft Systems Act" that explicitly preempted local governments from regulating a wide assortment of UAS-related activities—including design, manufacture, and

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105. HAMILTON, *supra* note 61, at 21; *see also* Cecilia Kang, *FAA Drone Laws Start to Clash with Stricter Local Rules*, N.Y. TIMES (Dec. 27, 2015), https://nyti.ms/348Vt4S.

106. *See generally* TIMOTHY M. RAVICH, COMMERCIAL DRONE LAW: DIGEST OF U.S. AND GLOBAL UAS RULES, POLICES, AND PRACTICES (Am. Bar Ass'n 2017).

107. An Act Concerning Municipalities and Unmanned Aircraft, S.B. 975, Gen. Assemb., Jan. 2017 Sess. (Conn. 2017) (enacted), https://bit.ly/3a0clvW; Unmanned Aircraft Systems Research, Development, Regulation, and Privacy Act of 2015, S.B. 370, Reg. Sess. (Md. 2015) (enacted), https://bit.ly/2XtovLk; Aircraft Certain; Local Regulation, H.B. 412, Reg. Sess. (Va. 2016) (enacted), https://bit.ly/2XqI7Qj.

108. Unmanned Aircraft: Prohibited Operations, S.B. 1449, 52d Leg., (Az. 2016), *available at* https://bit.ly/3b1vKhs.

109. *Id.*

operator credentialing—except in matters relating to "nuisances, voyeurism, harassment, reckless endangerment, property damage, or other illegal acts arising from the use of unmanned aircraft systems."[110] To a large extent, the number of state laws respecting UAS is owed to the fact that state legislatures were frustrated with and tried to fill gaps caused by the FAA's pace of UAS rulemaking.

Fortunately, efforts are underway in the UAM space that feature a level of cooperation not initially achieved for UAS owners and operators. As an aviation executive testified, despite the local integration needs of UAM,

> it is important that standards for the aircraft and for operations are common across the US and preferably across the globe. To that end, it is important that federal preemption for the FAA in the area of aviation is respected legislatively and judicially. Close coordination and cooperation with governments and regulatory agencies is critical for the development of appropriate regulation that provides a clear path to compliance and authorization to operate with guardrails, rather than roadblocks.
>
> Furthermore, the FAA, EASA and other regulators should work together to develop a globally coordinated safety system expectations through agreed upon consensus standards that ensure the viability of reciprocal airworthiness acceptance. We are encouraged in this regard by recent progress, including the activity of the General Aviation Manufacturers Association Electric Propulsion Innovation Committee ("GAMA EPIC"), which has brought both voices to the conversation together, and we encourage both agencies to seek opportunities for continued collaboration.[111]

Additionally, along with NASA's "Grand Challenge,"[112] the Unmanned Aircraft System Integration Pilot Program ("UAS IPP") offers

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110. An Act Relating to Unmanned Devices, H.B. 1027, 2017 Leg., (Fl. 2017), *available at* https://bit.ly/2xb7RFO. The proposed law specifically stated that, "[t]he authority to regulate the operation of unmanned aircraft systems is vested in the state except as provided in federal regulations, authorizations, or exemptions." *See id.* The law further established that a political subdivision of the state was forbidden from enforcing an ordinance or resolution "relating to the design, manufacture, testing, maintenance, licensing, registration, certification, or operation of an unmanned aircraft system, including airspace, altitude, flight paths, equipment or technology requirements; the purpose of operations; and pilot, operator, or observer qualifications, training, and certification." *See id.* That said, the law did not "not limit the authority of a local government to enact or enforce local ordinances relating to nuisances, voyeurism, harassment, reckless endangerment, property damage, or other illegal acts arising from the use of unmanned aircraft systems if such laws or ordinances are not specifically related to the use of an unmanned aircraft system for those illegal acts." *See id.*

111. *See* Thacker Testimony, *supra* note 12.

112. Graham Warwick Washington, *Grand Challenge will bring NASA, FAA and Industry Together on UAM*, AVIATION WK. & SPACE TECH. (Sept. 18, 2019),

a hopeful model for UAM firms. Begun in 2017, the UAS IPP has brought state, local, and tribal governments together with private sector entities, such as UAS operators or manufacturers, to test and evaluate the integration of civil and public drone operations into the NAS.[113] In doing so, the program assists the FAA in crafting new rules that support more complex low-altitude operations by: identifying ways to balance local and national interests related to drone integration; improving communications with local, state and tribal jurisdictions; addressing security and privacy risks; and accelerating the approval of operations that currently require special authorizations.[114] The program has created "a meaningful dialogue on the balance between local and national interests related to drone integration, and provide actionable information" to federal regulators.[115] In all, these and other programs may represent significant progress in avoiding or mitigating thorny issues of preemption among local, state, and national authorities.

C. Airspace

As with drones, UAM operations implicate important property-related questions—on and above the ground. These questions include control and ownership of vertiport locations, charging stations for UAM flight, and operations near and above privately-owned homes, downtown office buildings, commercial spaces, and public forums like stadiums and parks. In traditional aviation matters, an airport's location and how its activities might impact the neighboring community are typically matters of land use and zoning that fall wholly or partially within the jurisdiction of the affected local government and municipality. Whether local authorities will oversee the highways—literally, the airspace—needed for UAM above their geographic boundaries is unclear, however.

Wholly *intra*-city UAM operations seemingly fall within the police powers of local governments in matters related to general health, safety, and welfare. But federal aviation regulators have increasingly staked out authority over all airspace "above the grass." What is more, longstanding legal precedent seems to confer the national government with vast powers over all airspace, albeit without also specifying where, if anywhere, state and local powers end and where federal powers begin in the sky.

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https://go.nasa.gov/2y8LBfS ("The primary goal of GC-1 is to accelerate the UAM market by collecting flight data to help the FAA develop test procedures, data requirements and compliance methods for electric vertical-takeoff-and-landing (eVTOL) vehicle and pilot certification as well as operational approval.").

113. *See UAS Integration Pilot Program*, FED. AVIATION ADMIN., https://bit.ly/2VnJEUN (last modified Dec. 10, 2019, 2:58 PM).

114. *See id.*

115. *Id.*

To illustrate, *United States v. Causby* is often cited as the seminal case in which the United States Supreme Court recognized realities borne of the jet age, nationalizing control over airspace by abandoning the Roman doctrine of *cujus est solum ejus usque ad coelom*—"whoever owns the soil, it is theirs up to Heaven."[116] In fact, *Causby* effectively capped private property rights to "the immediate reaches above the land," affording public and private aviators an easement in the air—an avigational easement—subject not to the mechanically applied law of trespass but to the equitable balancing tests of takings law and eminent domain.[117] But, in the more than 70 years since *Causby*, the Supreme Court has not identified a specific altitude as part of its "the immediate reaches above the land" formulation. Consequently, state legislatures and courts, together with federal aviation regulators, have filled the void, generally regarding (without formally establishing) 500 feet above ground level as the extent of private property ownership in urban areas.[118]

While this might suggest that local or state governments have jurisdiction over aviation operations below 500 feet, the analysis is complicated by a proposition that has served national aviation policy for more than six decades. Specifically, the federal government, through the FAA, has exclusive jurisdiction over airspace that includes aeronautical activities on the ground. As explained by Justice Jackson in the 1944 decision of *Northwest Airlines, Inc.*:

> Congress has recognized the national responsibility for regulating air commerce. Federal control is intensive and exclusive. Planes do not wander about in the sky like vagrant clouds. Rather, they move only by federal permission, subject to federal inspection, in the hands of federally certified personnel and under an intricate system of federal commands. The moment a ship taxies onto a runway it is caught up in an elaborate and detailed system of controls. It takes off only by instruction from the control tower, it travels on prescribed beams, it may be diverted from its intended landing, and it obeys signals and orders. Its privileges, rights, and protection, so far as transit is concerned, it owes to the Federal Government alone and not to any state government.[119]

To be sure, the justification for nationalizing responsibility for safe and efficient air navigation for traditional aviation operations is compelling. General and commercial aviation involves almost 29.4 million square miles of airspace and millions of people traveling daily by air over an area that represents more than 17% of the world's airspace, including all of the

116. *See* United States v. Causby, 328 U.S. 256, 261 (1946).
117. *Id*. at 266.
118. *See, e.g.*, Florida v. Riley, 488 U.S. 445, 451 n.3 (1989).
119. *See* Nw. Airlines, Inc. v. Minnesota, 322 U.S. 292, 303 (1944).

United States and large portions of the Atlantic and Pacific Oceans and the Gulf of Mexico.[120]

ODM, in contrast, is forecast to cover a substantially smaller distance with few passengers per flight. Nevertheless, the FAA is likely to remain the final authority over ODM operations, primarily in the interest of safety. Indeed, Congress enacted the Federal Aviation Act of 1958, unifying air space management under the FAA's authority.[121] The FAA's authority to manage and determine uses of the NAS are exclusive and indivisible. Under 49 U.S.C. § 40101, the FAA has broad authority to regulate, control, develop plans, and form policy for the use of navigable airspace.[122] Congress also vested the FAA with authority to "develop plans and policy for the use of the navigable airspace and assign by regulation or order the use of the airspace necessary to ensure the safety of aircraft and the efficient use of airspace."[123] With that authority, the FAA divided the national airspace into regulatory airspace (*i.e.,* Class A, B, C, D, and E airspace areas, restricted and prohibited areas) and non-regulatory (*i.e.*, military operations areas ("MOAs"), warning areas, alert areas, and controlled firing areas.). Within these two categories, there are four types of airspace: controlled; uncontrolled (*e.g.*, Class G airspace is uncontrolled airspace); special use, and other airspace; extending to outer space (flight level 60,000 feet ("FL 600")),[124] as illustrated below:[125]

120. FED. AVIATION ADMIN., AIR TRAFFIC ORGANIZATION (Dec. 5, 2017), https://bit.ly/2V2gie7.

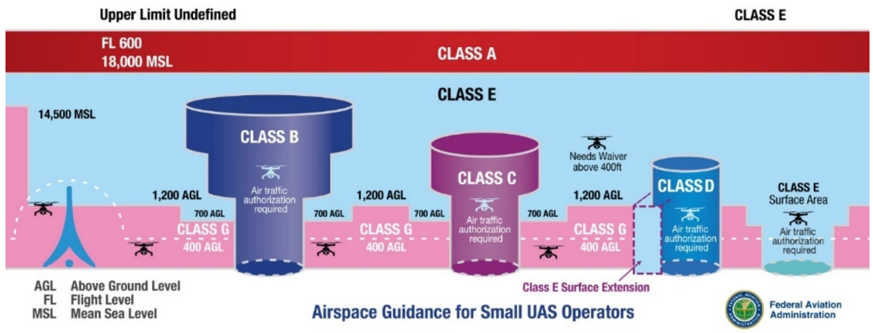
121. Federal Aviation Act of 1958, Pub. L. No. 85-726, 72 Stat. 731 (1958).

122. *See* 49 U.S.C. § 40101(d) (providing that the FAA must consider several matters as being in the public interest: (1) assigning, maintaining, and enhancing safety and security as the highest priorities in air commerce; (2) regulating air commerce in a way that best promotes safety and fulfills national defense requirements; (3) encouraging and developing civil aeronautics, including new aviation technology; (4) controlling the use of the navigable airspace and regulating civil and military operations in that airspace in the interest of the safety and efficiency of both of those operations; (5) consolidating research and development for air navigation facilities and the installation and operation of those facilities; (6) developing and operating a common system of air traffic control and navigation for military and civil aircraft; and (7) providing assistance to law enforcement agencies in the enforcement of laws related to regulation of controlled substances, to the extent consistent with aviation safety).

123. 49 U.S.C. § 40103(b) (2018).

124. *See* FED. AVIATION ADMIN., CLASSES OF AIRSPACE, https://bit.ly/348QxwS.

125. FED. AVIATION ADMIN., AIRSPACE 101 — RULES OF THE SKY, fig. Airspace Guidance for Small UAS Operators (Oct. 30, 2018), https://bit.ly/2X4SxVs.



How and where UAM operations will fit into this regulatory scheme is unclear, as is whether federal authorities (not local or state regulators) will have the power to regulate access and control of the altitude airspace *beneath* the NAS (*e.g.*, 400–500 feet above ground level).

UAM aircraft are not monolithic, of course, and the variety of potential UAM aircraft types presents unique challenges to regulators responsible for airspace integration.[126] Cruise speeds for UAM aircraft will range from approximately 70 knots to 200 knots or more (*i.e.*, 80 to 230 miles per hour) and different eVTOL will feature hovering capabilities that may vary from ninety seconds to multiple tens of minutes. "These variations in performance will have significant implications on airspace design and operating procedures for airspace integration, such as holding patterns near vertiports, right-of-way rules, and/or constraints on vertiport access to vehicle classes with compatible operating envelopes."[127] Moreover:

> [b]y definition, the scope of UAM operations is within a metropolitan area . . . For metropolitan areas that are located further away from airports, UAM operations would have their origin, their destination, or both, be in Class E or Class G airspace. Although Class E airspace is controlled airspace, aircraft operating under [visual flight rules] in Class E airspace are not required to be in contact with ATC [air traffic control].
>
> This is also true of flights in Class G, which is uncontrolled airspace. On the other hand, for metropolitan areas that are located near airports, UAM operations may be conducted entirely within Class B airspace

126. The Vertical Flight Society has tracked a total of more than 200 different aircraft designs by companies claiming to have eVTOL aircraft, though few have significant financial backing. *See* Press Release, Vertical Flight Soc'y, Vertical Flight Society Reports More than 200 eVTOL Aircraft Now in Development (Sept. 8, 2019), https://bit.ly/2wbPPTf. In 2019, the FAA issued a Request for Information to the eVTOL industry to begin the process of developing policy guidance for testing and certifying eVTOL. *See* FED. AVIATION ADMIN., VERTICAL TAKEOFF AND LANDING DESIGNS (Apr. 3, 2019), https://bit.ly/39Jh6Ki.

127. *See* Thipphavong et al., *supra* note 8, at 7–8.

> around major airports, Class C airspace around medium-sized airports, or Class D airspace around smaller airports.
>
> For example, downtown Dallas lies entirely within Class B airspace due to its proximity to Dallas-Fort Worth airport. The extent to which UAM operations would be allowed to occur in these classes of airspace would depend on the departure location, arrival location, and/or constraining factors (*e.g.*, noise restrictions and obstacles). Under present-day rules, UAM flights would be required to communicate with ATC prior to entering Class B, C, or D airspace.[128]

As such, the amount of coordination as a practical and legal matter for UAM operations will be extensive.

Recently, NASA developed a set of guiding principles informed by prior work on ODM tenets related to UAM airspace integration concepts, technologies, and procedures that could evolve as NASA learns and collaborates with the UAM community and the broader aviation community.[129] The principles include:

1. UAM should require minimal additional ATC infrastructure (*e.g.*, radar systems, controller positions) and minimal changes to FAA automation systems used for ATC.
2. UAM should impose minimal additional workload on controllers beyond their current duties for existing airspace users.
3. UAM should impose minimal additional requirements or burdens on existing airspace users beyond equitable access to airspace resources.
4. UAM will meet the regulatory requirements for vehicle-level and system-level safety and security, such as timely and assured data exchange and the elimination of single points of failure and common failure triggers.
5. UAM will be resilient to a wide range of disruptions, from weather and localized sub-system failures (*e.g.*, a single vehicle or software tool) to widespread disruptions (*e.g.*, GPS failure).
6. UAM will economically scale to high-demand operations with minimal fixed costs.
7. UAM will support user flexibility and decision making to the greatest extent possible.

Although a step forward, these principles leave unresolved the important issue of implementation among federal, state, and local regulators. For that matter, regulators at various levels of government will need to achieve significant

128. *Id.*
129. *See id.*

cooperation if UAM ideas are to succeed, and it seems that local authorities will need to work around federal regulators, not the other way around. As the FAA stated in a "Fact Sheet" in December 2015 entitled "State and Local Regulation of Unmanned Aircraft Systems (UAS),"[130] state and local restrictions "should be consistent with the extensive federal statutory and regulatory framework pertaining to control of the airspace, flight management and efficiency, air traffic control, aviation safety, navigational facilities, and the regulation of aircraft noise at its source."[131] In the context of drones, the FAA stated:

> Substantial air safety issues are raised when state or local governments attempt to regulate the operation or flight of aircraft. If one or two municipalities enacted ordinances regulating UAS in the navigable airspace and a significant number of municipalities followed suit, fractionalized control of the navigable airspace could result. In turn, this "patchwork quilt" of differing restrictions could severely limit the flexibility of FAA in controlling the airspace and flight patterns, and ensuring safety and an efficient air traffic flow. A navigable airspace free from inconsistent state and local restrictions is essential to the maintenance of a safe and sound air transportation system. [132]

While this may be true for the operation of commercial airliners flying over state lines, it is not clear that this conception of airspace necessarily holds for ODM where the local concerns may predominate over state and national policies.

D. Community Acceptance

Congress vested the FAA with exclusive authority to manage the national airspace system[133] only after several tragedies exposed unacceptable flaws in the government's approach to airspace management. In 1956, a TWA Constellation and United Airlines DC-7 collided and fell into the Grand Canyon. A year later, debris from a mid-air collision involving a United States Air Force jet fell onto a junior high school playground, killing three students and injuring 70 others.[134] As a consequence of these tragedies, Congress airspace management under the authority of the FAA, and in no small measure, modern commercial airline travel safety is extraordinarily safe as a direct result. As a Dutch aviation consulting firm

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130. FED. AVIATION ADMIN., STATE AND LOCAL REGULATION OF UNMANNED AIRCRAFT SYSTEMS (UAS) FACT SHEET 1, 1 (Dec. 17, 2015), https://bit.ly/2X6ZCVv [hereinafter Fact Sheet].

131. *Id*.

132. *Id.* at 2 (first citing Montalvo v. Spirit Airlines, 508 F.3d 464, 473 (9th Cir. 2007); French v. Pan Am Express, Inc., 869 F.2d 1, 6 (1st Cir. 1989); then citing Arizona v. United States, 567 U.S. 387, 401 (2012) ("Where Congress occupies an entire field . . . even complimentary state regulation is impermissible. Field preemption reflects a congressional decision to foreclose any state regulation in the area, even if it is parallel to federal standards."); and then citing Morales v. Trans World Airlines, Inc., 504 U.S. 374, 386–87 (1992)).

133. *See supra* Section III.C.

134. *See* 2 U.S. CODE CONG. & AD. NEWS, 85th Cong., 2d Sess., pp. 3741–42 (1958).

estimated in 2018, the fatal accident rate for large commercial passenger flights is 0.06 million flights, or one fatal accident for every 16 million flights.[135]

For aerial ridesharing to attain popular and mass-scale acceptance and adoption at similar scale—not only from potential passengers but also from third parties impacted by ODM—UAM firms will likely need to match the safety rate of commercial airliners and certainly will need to exceed the accident rate of automobiles. In this context, Uber has framed the critical issue of UAM safety as a function of community acceptance not of commercial airplanes, but of traditional cars:

> For widespread public adoption of VTOLs as a ridesharing option, riding in a VTOL must be safer than riding in an automobile. In order that VTOLs are accepted by the market, claiming that the vehicles are merely as safe as driving, particularly given the active public discourse regarding potential safety improvements from autonomous vehicles, will almost certainly be insufficient. Additionally, the general public is very aware that flying commercial airlines is significantly safer than driving, which puts upward pressure on safety of any aviation offering, especially one intended for daily use.
>
> While scheduled airlines operating under [14 C.F.R.] Part 121 of the FAA Federal Aviation Regulations ("FAR") will almost certainly remain the safest mode of transport, our initial target is to achieve a safety level that is twice that of driving a car based on number of fatalities-per-passenger mile. Today, using [14 C.F.R.] Part 135 helicopter and fixed-wing operations as the closest proxy, *the safety level in air-taxi aviation is two times worse than driving, which means we would need to see an improvement of four times (from 1.2 to 0.3 fatalities per 100 million passenger miles) to achieve that target*. It's important to note, however, that while we've set this goal, regulators would not necessarily require significantly more stringent VTOL safety targets than automobiles. Additionally, the regulatory discussion will be complex because safety can be measured on a number of dimensions (*e.g.* injuries, accidents).[136]

At one level, ODM aircraft, like aircraft generally, may offer safety mechanisms not achievable by car. On the other hand, on-demand aviation presents severalhazards that are both unique and incomparable to cars—the operator (a human being or autonomous computer) cannot just pull over to the side of the road.

Among the top concerns associated with UAM arethe airplanes themselves. This includes the potential for loss of electrical power to control systems, the risk of vehicle fly-away, failure of autonomous systems and critical sensors and sensor

135. *See, e.g.*, David Shepardson, *2017 Safest Year on Record for Commercial Passenger Air Travel*, REUTERS (Jan. 1, 2018), https://reut.rs/2URV0jl.

136. UBER ELEVATE, *supra* note 1, at 16 (emphasis added).

arrays, and servicing and maintenance.[137] These concerns are in addition to externalities like the loss of safety-critical functions at a ground station, inadequate pilot training, lack of vertiport availability, inadequate ground crew, passenger interference with pilot or vehicle operations, passenger illness during flight, and cybersecurity and hijacking of communication and control links.[138] And, of course, the most significant externality of all—the environment—looms in the nature of weather (*i.e.*, convective weather like hail and severe downdrafts), obstacles like buildings, power lines, airborne vehicles, and birds.[139]

Even if these safety concerns can be allayed, the issue of noise presents another significant barrier to wide-spread UAM acceptance. As Uber has noted, "VTOLs will operate directly overhead, and in close proximity to, densely populated urban areas . . . While communities tend to tolerate public safety flights (such as medical helicopters) because the flights are infrequent and have clear community value, they historically oppose other uses due to noise."[140] In his congressional testimony, Michael Thacker, the Executive Vice President for Technology and Innovation at Bell, framed the issue of UAM noise in this way:

> [W]e plan to be operating in urban areas, in and around a lot of people. This comes with a safety expectation that protects both passengers and people on the ground, even in failure scenarios. It will also require an affordable solution accessible by most people. This is critical to acceptance—why would people accept aircraft operating in their neighborhood if they can't take advantage of them?
>
> Another critical component of acceptance is managing the acoustic signature of ODM aircraft. One of the greatest hindrances to vertical lift operations in cities today is noise. To succeed in urban environments, breakthrough reductions in vehicle noise generation are a must.[141]

In all, if aerial ridesharing is to get to market and exist as a sustainable mode of transportation, UAM firms will need to satisfy the concerns of two communities primarily: regulators and the general public. Notwithstanding the diversity of regulators and communities that UAM will impact, safety and noise are common concerns. And, in that regard, UAM manufacturers will need to comply with the regulations promulgated by aviation authorities around the globe, including standards for vehicle design, production, pilot licensing, and maintenance and operating requirements.[142] The United States and European markets are key to achieving mass-scale adoption given that the FAA and EASA function as regulators for 50% and 30% of the world's aviation activity, respectively.[143] Altogether, the challenge of gaining community acceptance lies

137. *See* Thipphavong et al., *supra* note 8, at 9.
138. *See id.*
139. *See id*.
140. UBER ELEVATE, *supra* note 1, at 22. Under 14 C.F.R. Part 36, Subparts H and K, the FAA has set thresholds for community noise around airports for fixed-wing aircraft, helicopters, and tiltrotors.
141. *See also* Thacker Testimony, *supra* note 12.
142. *See* UBER ELEVATE, *supra* note 1, at 22.
143. *See id*.

in the fact that there are many different types of communities and stakeholders which UAM manufacturers, owners, and operators must address.

IV. POLICY CONSIDERATIONS

Like commercial drones, aerial ridesharing at mass-scale epitomizes the "Internet of Things" and the modern era in which rare technologies are pervasive in both effect, ownership, and use.[144] But, as an *Economist* article stated in the context of drones:

> Moving bits around the internet is one thing; moving atoms around in the real world is something else entirely. In the two decades of the internet era, many world-changing technologies—web-publishing, file-sharing, online auctions, internet telephony, virtual currencies, ride-hailing—have raised new legal and regulatory questions. In each case, regulators had to work out the rules after the event: figuring out how libel law applies to the web, banning the sale of Nazi memorabilia, deciding whether Bitcoin is a currency, determining whether Uber drivers are employees or contractors, and so on. But drones are a different matter, because of the danger that flying robots pose to life and limb, and the existence of strict rules that govern the use of physical airspace. Their future will depend as much on decisions made by regulators as it does on technological advances. How will it play out?[145]

Historically, the answer—from bicycles[146] to cars[147] to airplanes[148]—has been that regulators outlaw or impede the ownership and/or use of disruptive technologies until the safety of the innovation is established and/or society accepts the risks attendant to a particular innovation, trading off its drawbacks with its benefits. That has been, and likely is, the regulatory trajectory for UAM firms.
Unfortunately, if that is the case, the benefits of UAM "may not come about if preemptive, precautionary policy interventions limit new innovation opportunities."[149] In the drone space, for example, precautionary, principle-based policymaking based on ephemeral fears and stringent prophylactic restrictions, including untimely rulemaking, aggressive enforcement arguably at odds with historic policy guidance, regulatory decisions made with incomplete data and

144. *See, e.g.*, Susan W. Brenner, *Law in an Era of Pervasive Technology*, 15 WIDENER L.J. 667, 669 (2006) ("[I]nstead of being an externality, something we consciously utilize for a specific purpose, pervasive technology disappears into the background and becomes an integral part of our lives.").

145. *The Future of Drones Depends on Regulation, not just Technology*, ECONOMIST (June 10, 2017), https://econ.st/3bLd59U.

146. *See, e.g.*, State v. Yopp, 97 N.C. 477, 481 (1887).

147. *See, e.g.*, Lewis v. Amorous, 59 S.E. 338, 341 (Ga. Ct. App. 1907).

148. Early courts characterized aviation an ultra-hazardous activity to which the doctrine of *res ipsa loquitur* applied. *See generally* Nw. Airlines, Inc. v. Rowe, 226 F.2d 365 (8th Cir. 1955).

149. Adam D. Thierer, *The Internet of Things and Wearable Technology: Addressing Privacy and Security Concerns without Derailing Innovation*, RICH. J.L & TECH., 2015, at 117.

overreach has limited the rate of growth of an emerging industry.[150] As such, one scholar argues a different approach:

> [Perhaps t]he better alternative to a top-down regulation is to deal with concerns creatively as they develop, using a combination of educational efforts, technological empowerment tools, social norms, public and watchdog pressure, industry best practices and self-regulation, transparency, and targeted enforcement of existing legal standards (especially torts) as needed. This bottom-up and layered approach to dealing with problems will not preemptively suffocate technological experimentation and innovation in these spaces.[151]

In this framework, treating ODM as a "permissionless innovation" may be appropriate whereby,

> experimentation with new technologies and business models should generally be permitted by default. Unless a compelling case can be made that a new invention will bring serious harm to individuals, innovation should be allowed to continue unabated, and problems—if they develop, at all—can be addressed later. Permissionless innovation is not an absolutist position that denies any role for government. Rather, it is an aspirational goal that stresses the benefit of pushing "innovation allowed" as the best default position to begin debates about technology policy. The burden of proof is on those who favor preemptive, precautionary controls to explain why ongoing trial-and-error experimentation with new technologies or business models should be disallowed.[152]

To be clear, regulators have an important and appropriate role to play in the UAM space. As a threshold matter, aviation regulators ought to play a material role in the certification and testing of eVTOL. As two fatal crashes of the Boeing 737 MAX are proving, regulatory lapses have dire consequences in aviation and the opportunity for firms to shirk regulatory requirements if left alone is real.[153] But, the potential benefits of UAM will not be possible if the precautionary regulatory configuration historically associated with disruptive technologies prevails.

In this sense, the work of Harvard Law Professor, Lawrence Lessig, may offer a productive analytical framework for realizing UAM. His socio-economic theory, or New Chicago School theory, of regulation imagines four regulatory forces: the law; social norms; the market; and architecture.[154]

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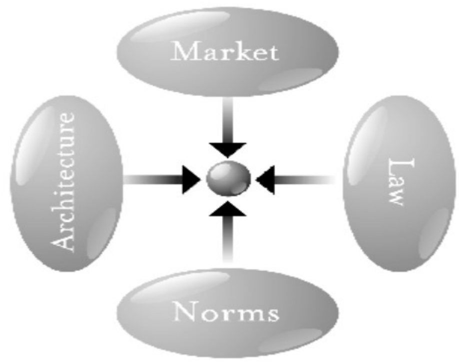
150. *See, e.g.*, Timothy M. Ravich, *Grounding Innovation: How Ex-Ante Prohibitions and Ex-Post Allowances Impede Commercial Drone Use*, 2018 COLUM. B. L. REV. 495, 580 (2018).

151. Thierer, *supra* note 149, at 3–4.

152. *Id*. at 39–40.

153. *See, e.g.*, Andy Pasztor & Alison Sider, *Boeing Workers Made Light of MAX Safety*, WALL ST. J., Jan. 10, 2020, at A1.

154. *See* Lawrence Lessig, *Pathetic Dot Theory*, WIKIMEDIA COMMONS (Mar. 14, 2013, 5:09 PM), https://bit.ly/2JF8E4l.



In this scheme, each force applies pressure in the direction of an overarching policy goal—in the case of UAM: high-density, high-tempo aerial ridesharing between and within suburbs and cities. Lessig used seatbelts to illustrate his theory:

> The government may want citizens to wear seatbelts more often. It could pass a law to require the wearing of seatbelts (law regulating behavior directly). Or it could fund public education campaigns to create a stigma against those who do not wear seatbelts (law regulating social norms as a means to regulating behavior). Or it could subsidize insurance companies to offer reduced rates to seatbelt wearers (law regulating the market as a way of regulating behavior). Finally, the law could mandate automatic seatbelts, or ignition-locking systems (changing the code of the automobile as a means of regulating belting behavior). Each action might be said to have some effect on seatbelt use; each has some cost. The question for the government is how to get the most seatbelt use for the least cost.[155]

Like seatbelt usage, the goal of UAM can be encouraged by the law, market, product architecture, and public understanding. And, in fact, that is happening.

Unlike the tug of war and preemption fights between states and the federal government that occurred in the ramp up to commercial drone regulations, lawmakers are approaching UAM relatively more collaboratively and cooperatively.[156] Regulators are also embracing market-based approaches to encouraging UAM. including with its "Grand Challenge" initiative designed to provide a proving ground where NASA, vehicle providers, airspace technology providers, and the public will learn what it really requires to achieve UAM.[157] Product architecture is also encouraging UAM viability and acceptance as vehicles themselves are outfitted with extraordinary safety capabilities. For example, by avoiding the use of a large rotor, a DEP aircraft is able to take advantage of Ballistic Recovery Systems ("BRS"). BRS provide whole vehicle

155. LAWRENCE LESSIG, CODE AND OTHER LAWS OF CYBERSPACE 93–94 (New York: Basic Books, 1999).
156. *See supra* notes 104 & 105 and accompanying text.
157. *See supra* notes 104 & 105 and accompanying text.

parachutes that can be deployed in an emergency to safely bring the vehicle to the ground, and allow the aircraft to avail itself of other evolving safety technologies being tested such as whole aircraft airbags.[158] Finally, social norms may be changing as an Airbus survey of more than 1500 respondents in Mexico City, Los Angeles, Switzerland, and New Zealand, showed that 44% supported, or strongly supported, deploying unmanned traffic management ("UTM"), a critical component of making UAM a reality.[159] All of these factors trend favorably for UAM firms.

But, all of this assumes that governmental actors (at the local, state, or national levels) desire UAM. According to a Booz Allen Hamilton market study, desire for UAM is not universal. Places like Phoenix, Miami, San Diego, and Orlando currently have favorable regulations for UAM. But areas that most need relief from traffic, including New York, Washington, D.C., and Boston, have an unfavorable regulatory environment for UAM.[160] The bottom line, therefore, is that persuading lawmakers that UAM is achievable and desirable is a significant impediment at the outset of the ODM research and investment.

V. CONCLUSION

Among the biggest consumer trends in 2020 is the goal of better travel. In this regard, the appetite for UAM and ODM is great and underserved:

> As the world's population becomes increasingly urban, residents are growing frustrated with congested roads and overcrowded public transportation. More people now turn to navigation apps to plan their journeys and offer real-time updates on the best way to travel via train, taxi, electric bike, scooter, helicopter or a customized combination of them all. "Consumers want their transportation across cities to be modular and personalized to their individual needs in 2020 as they embrace a crowded world that is no longer seen as car-first," Euromonitor says.[161]

Of course, more consumers expect customized products and services for themselves, this expectation does not readily translate into embracing the possibility of flying in pilotless airplanes just above tall buildings in "smart" cities. For that matter, substantial literature exists about the fear many people have of flying in traditional aircraft,[162] and narratives that catastrophize the advent of flying cars further complicate the prospect of ODM. Several known and unknown factors suggest that UAM may not occur (ever), or at least, that ODM may not achieve the type of high-tempo, high-density activities that some imagine in as little time as the next decade or two. In any case, from a legal and policy

158. *See* UBER ELEVATE, *supra* note 1, at 21.

159. *See Urban Air Mobility: On The Path to Public Acceptance*, AIRBUS (Feb. 11, 2019), https://bit.ly/2JBhUGz.

160. *See* HAMILTON, *supra* note 61, at 16.

161. Ellen Byron, *Top Consumer Trends for 2020*, WALL ST. J., Jan. 15, 2020, at A11.

162. *See* Margaret Oakes & Robert Bor, *The Psychology of Fear of Flying (Part I): A Critical Evaluation of Current Perspective on the Nature, Prevalence and Etiology of Fear of Flying*, 8 TRAVEL MED. & INFECTIOUS DISEASE 327 (2010).

perspective, UAM represents one of the rare disruptive technological innovations for which the law can lead.