NEOFIX
Northeast Ohio Flight Information Exchange

A position paper

Creating Drone Ready Infrastructure: Advanced Air Mobility Operations in Northeast Ohio

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Introductory Message to NEOFIX Stakeholders

The Northeast Ohio Flight Information Exchange or NEOFIX is a Baldwin Wallace University applied research and technology transfer project funded by Cuyahoga County and the State of Ohio https://bw-centers-tech-partnerships.org/neofix-overview/. The NEOFIX instrument – which provides flight information data and flight advisories to the public https://oh-fix.com/index.html - is an early step toward creating the best possible conditions for drone infrastructure and drone operations in the region. Among the best features of this project is of that NEOFIX public-private partnership serves as a model for replication in all of Ohio's 88 counties.

In my work in developing and leading higher education sponsored research projects, I have found that concept papers offer a reasonable pathway to share ideas to larger audiences, informing and educating stakeholders and others about a specific topic and its problems. Such thought pieces can provide solutions and recommendations and are often used in public and private settings.

TAB 1 that follows is an opinion paper intended to add to the discourse on drone infrastructure in Northeastern Ohio. **TAB 2** offers suggestions to Ohio policy makers on the larger concept of Advanced Air Mobility or AAM for use in commercial and civilian applications.

While the responsibility for this document is mine (**Stuart C. Mendel**) alone in service as NEOFIX project director https://www.linkedin.com/in/stuart-c-mendel/, the contents are the product of a group effort, who are highly capable, experienced and knowledgeable practitioners of the field.

Kindly note an acknowledgement and appreciation is extended to:

Marlin Linger, MS, MBA; https://www.linkedin.com/in/marlin-linger-699403260/ FAA Part 107 Licensed Unmanned Aerial System (UAS) (Drone) Pilot; Vice President (Acting President) of the Lorain County Remote Control Club; Former Program Manager for a NASA and Ohio Aerospace Institute UAS training program for Ohio community college students. In addition he served as USAF Officer and Scientist at the Air Force Research Laboratory at Wright Patterson AFB, OH.

Kyle Snyder - Flyabout Strategies, LLC. https://www.linkedin.com/in/ktsnyder/ Kyle Snyder has more than 20 years now in aerospace/aviation and unmanned systems technology transfer and development.

John Eberhardt - Managing Director at ATA Aviation. https://www.linkedin.com/in/john-eberhardt-6734163/ ATA Aviation is building the public digital backbone of AAM, supporting the exchange of next-generation navigational and safety data.

Chelsea Treboniak - Owner of Critical Ops, a Business Integration Company. https://www.linkedin.com/in/chelseatreboniak/

Howard Thompson - Director of Business Development, Manufacturing Works. https://www.linkedin.com/in/howard-thompson-b255667/

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TAB 1

Introduction

Advanced Air Mobility (AAM) refers to a revolutionary transportation system that utilizes new types of aircraft to move people and cargo within urban and regional areas, as well as for intercity travel and other applications. It involves the use of manned and unmanned aircraft. FAA, NASA, and state governments are preparing to support AAM through research, proof-of-concepts, and infrastructure investments. Industry is accelerating the developments of electric vehicles, autonomous systems, and digital communications that will enable complex operations. Northern Ohio is well prepared to demonstrate the potential of this technology and the economic impacts associated with embracing more access to the skies. This white paper discusses various issues that may be involved in integrating such a system into the northeast Ohio airspace.

Background

Advanced Air Mobility (AAM) envisages a new age of aviation. AAM imagines a future where electric or hybrid-powered aircraft take flight, offering on-demand transportation services. These new generation vehicles are designed for electric vertical takeoff and landing (eVTOL), eliminating the need for long runways. Ohio intends to apply AAM for the safe, efficient, and equitable transportation of people and goods throughout the state (https://drive.ohio.gov/programs/aam).

A study produced by Crown Consulting Inc., NEXA Capital Partners LLC, and the University of Cincinnati produced a comprehensive economic impact report for the integration of next-generation aircraft into Ohio's airspace. The report provided an analysis of Ohio's current infrastructure and assets in addition to identifying future needs to make this new aviation technology a reality. It concluded that the state of Ohio could expect $13 billion economic impact over 25 years by investing in advanced air mobility infrastructure and technologies.

If Ohio can capture this emerging market, researchers determined that Ohio could expect advanced air mobility to contribute 15,000 new jobs, $2.5 billion in local,

state, and federal tax revenues, and 1.6% GDP growth through 2045 (https://drive.ohio.gov/programs/aam/economic-impact).

AAM use cases

AAM has the potential for creating new businesses, new jobs, and new ways to use air transportation services. The purposes or uses for AAM cross many sectors of the economy.

1. **Regional Urban Air Mobility (RAM):** Regional Air Mobility (RAM) is expected to be one of the early uses for the capability to connect suburbs and smaller cities. Urban Air Mobility (UAM) concepts envision flying taxis and autonomous passenger drones flying between city rooftops.
2. **Public services:** Public services such as law enforcement, search and rescue operations, emergency response agencies, are preparing for expanded capabilities enabled through AAM infrastructure and accessibility.
3. **Cargo delivery:** Large cargo delivery aircraft will provide efficient and rapid movement of goods over shorter distances, especially between regional airports.
4. **Private transportation:** Personal eVTOL ownership for recreational or commuting purposes. AAM has the potential to revolutionize the way people travel. eVTOL aircraft could bypass traffic congestion by soaring over city streets. They could improve accessibility to remote areas and reduce travel times significantly.

NEO Economic Development Viability

At the center of AAM technologies are the new aircraft designs intended to provide affordable, easy to operate, possibly autonomous, probably electric transportation methods. These range in size from small drones weighing less than 55 lbs, to large cargo-only aircraft, to full-scale passenger carrying aircraft designs. Most of these designs are built using modern advanced manufacturing techniques with composite materials for mass production of light-weight structures. The

propulsion systems are a combination of multi-rotor lift systems, or potential conventional propellor systems, using electric or hybrid motors for power.

In addition to the advanced aircraft designs, new technologies for managing increased air traffic systems include concepts such as eXtensible Traffic Management (XTM). This is a combination of software, infrastructure, and procedures for deconflicting flight paths and providing airspace managers-awareness of activities in the area. Those activities may be small drones flying at low altitudes, personal aircraft eVTOLs, or commercial service large jets- all operating cooperatively within the same airspace. Technologies for the information that feed this management service, such as weather, prioritizations, security, and more will continue to evolve.

The digital transformation of aviation has already begun. Aircraft navigation is based on GPS sensors and internal measurement units providing data on acceleration, rotation, and tilt, which is crucial for stable flight control. Traffic sensors such as ADS-B, remote ID, and video are used for airspace deconfliction and security purposes. Digital payloads for environmental monitoring, video and LiDAR data collection, and more create new applications for AAM operators to expand services.

The traffic management system and the individual aircraft improve performance through communications connectivity when more data is shared with artificial intelligence tools that are distributed throughout the architecture. Onboard AI helps with route planning and traffic deconfliction on top of the existing automation in the auto-pilot flight controls. AI inside the XTM modules improves the performance the

traffic managers by processing more data and evaluating more alternatives.

AAM Challenges

While promising, adoption of AAM as effective method of transport is still in its early stages. Challenges include:

Infrastructure development: Creating landing pads, charging stations, and support facilities for AAM vehicles. A network of landing pads (vertiports) for eVTOL vehicles is needed. Infrastructure for airspace surveillance and communications is essential for transitioning air traffic management into a digital environment.

Public acceptance: Addressing noise concerns, safety anxieties, and privacy issues. Gaining public trust in the safety and noise profile of AAM vehicles is crucial. Addressing privacy concerns about constant drone traffic in urban areas is also important.

Considerations for air traffic management: Developing a safe and efficient system for integrating these new vehicles into existing airspace has several challenges, including:

> Unproven Technology: AAM vehicles, particularly electric vertical takeoff and landing (eVTOL) aircraft, are still under development. Extensive testing and certification are needed to ensure their safety for passengers and people on the ground.
>
> Air Traffic Management: Integrating a multitude of eVTOL vehicles into existing airspace with traditional airplanes, helicopters, and drones requires robust air traffic management systems to prevent collisions and maintain safety. Local airports are expected to see increased traffic, accessibility growth, and reduced noise from adoption of AAM aircraft. With those increases, there are challenges and considerations for airports in planning for AAM integration. Infrastructure needs, security requirements, and airspace updates will be defined for each airport. Impacts of AAM as

competition and collaboration through expansion of services will evolve as concepts mature.

Regulation Development: Regulations will evolve to support AAM operations. Certifications for eVTOL aircraft are current under development. Definitions for eVTOL flight routes are also actively in development. The FAA is anticipating the release of a proposed rule for beyond visual line of sight (BVLOS) flight operations in late 2024/early 2025. This proposed rule will define the requirements for package delivery drone certification and pilot qualifications. All AAM-style operations for the next 3-5 years are anticipated as operations approved under waivers while certifications and standards are developed to support operations at scale.

Technological Hurdles: Battery Technology: eVTOL vehicles rely on batteries for electric propulsion. Range limitations and long charging times are current constraints. Advancements in battery technology are crucial for increased range and shorter charging times.

Noise Pollution: While quieter than traditional helicopters, eVTOL noise during takeoff, landing, and flight could be a concern, especially in urban areas. Mitigating noise pollution is important for public acceptance.

High Development Costs: Developing and manufacturing modern aircraft is expensive, AAM designs are no different. The cost of manufacturing these vehicles and operational expenses are expected to come down as demand scales to make AAM a commercially viable alternative mode for transportation.

Market Uncertainty: The potential demand for AAM services is uncertain. Ridership needs to be high enough to justify the infrastructure investment and ensure profitability. Certification, entry-into-service, and infrastructure accessibility timelines are driving this uncertainty.

FAA as essential partner

Assuming that economically viable AAM aircraft can be produced and there are people who want to fly them in northeast Ohio airspace, how will such aircraft be flown so that they do not become a hazard to other manned or unmanned aircraft and people and objects on the ground? The FAA already has numerous regulations for manned aircraft of fixed wing and rotary wing (helicopter) varieties, as well as for airports and heliports. Airspace for such aircraft is controlled by a highly trained and equipped Air Traffic Control personnel. This system is adequate for aircraft travelling between airports and heliports, including new manned eVTOL air taxi aircraft operating between airports. However, new aircraft which do not have a human pilot on-board the aircraft, such as autonomous or remotely operated aircraft, need systems onboard and on the ground to avoid collisions with other aircraft.

Early considerations for FAA Aircraft Management

The FAA is most familiar with having human pilots on board aircraft to be able to detect and avoid other aircraft in their flight paths. Detect and avoid systems in unmanned aircraft are not yet capable of human level detection and avoidance. Consequently, unmanned aircraft are not authorized to fly in US airspace beyond the operator's visible line of sight (BVLOS), unless specifically authorized by the FAA to do so. This significantly reduces the range and utility of drone (unmanned aerial system or UAS) aircraft. Since Congress recognizes the potential future economic value and utility of drone aircraft, it has directed the FAA to develop a program to integrate UAS aircraft into the National Airspace System (NAS).

Until about 2012, GPS guided UAS aircraft were expensive and the purview of the military, but since then, the price and availability of such aircraft has come way down, making them economically viable for individuals and small companies to operate. This has greatly increased the number of such aircraft in the air and increased the possibility of collision with manned aircraft. The BVLOS requirement and a general limitation on the maximum altitude that UAS aircraft can fly (400 feet above ground level [AGL]) have helped keep UAS aircraft out of harm's way.

Most consumer grade drones (quadcopters) are made of plastic and have such a small RADAR cross-section that they cannot be readily detected by ATC radars at airports. Manned aircraft use the Automatic Dependent Surveillance - Broadcast (ADS-B) system to avoid collisions. However, ADS-B is covered by Federal Aviation Regulation (FAR) Part 91, and most small UAS or drones operate under FAR Part 107.

Unmanned Aircraft System Traffic Management (UTM)

The FAA has recently developed the Unmanned Aircraft System Traffic Management (UTM) system (https://www.faa.gov/uas/advanced_operations/traffic_management).

In 2023, the FAA published the UTM Implementation Plan in response to requirements from Congress in the FAA Reauthorization Act of 2018. This Plan addresses FAA's efforts to make UTM a reality, specifically its near-term and long-term plans, and the gaps in policy that must be resolved to have "full operational capability" of the UTM ecosystem. The FAA, NASA, other federal partner agencies, and industry are collaborating to explore concepts of operation, data exchange requirements, and a supporting framework to enable multiple beyond visual line-of-sight drone operations at low altitudes (under 400 feet above ground level (AGL)) in airspace where FAA air traffic services are not provided.

UTM is how airspace will be managed to enable multiple drone operations conducted beyond visual line-of-sight (BVLOS), where air traffic services are not provided. Unmanned Aircraft System Traffic Management (UTM) is a "traffic management" ecosystem for uncontrolled operations that is separate from, but complementary to, the FAA's Air Traffic Management (ATM) system. UTM development will ultimately identify services, roles and responsibilities, information architecture, data exchange protocols, software functions, infrastructure, and performance requirements for enabling the management of low-altitude uncontrolled drone operations.

With UTM, there will be a cooperative interaction between drone operators and the FAA to determine and communicate real-time airspace status. The FAA will provide real-time constraints to the UAS operators, who are responsible for

managing their operations safely within these constraints without receiving positive air traffic control services from the FAA. The primary means of communication and coordination between the FAA, drone operators, and other stakeholders is through a distributed network of highly automated systems via application programming interfaces (API), and not between pilots and air traffic controllers via voice.

UTM Key Site Operational Evaluation

In early 2023, the FAA evaluated new industry proposed *UTM capabilities and standards in support of small UAS operations*. These capabilities and standards are needed to support small UAS operations, such as package delivery, that are starting to happen more frequently and in the same areas. As these operations start to occur in overlapping areas, the risk of collision between drones increases, highlighting the need for a scalable approach to managing UA-UA conflicts.

UTM services offer a solution by providing a means for operators to collaboratively deconflict each other, which will help enable predictable and routine BVLOS operations in the National Airspace System (NAS). Other ways of managing collision risk, such as filing and reviewing Notices to Air Missions (NOTAMs), are not effective for automated, proximate operations at a rapid operational tempo.

The UTM Key Site Operational Evaluation (https://www.faa.gov/uas/research_development/traffic_management/UTM-Key-Site-Ops-Eval-Workshop.pdf) establishes partnerships with operators and UAS Service Suppliers (USSs) and works with suitable participants in attaining the necessary exemptions to operate BVLOS at a key site using UTM services. The FAA is also exploring how it will recognize the capabilities of USSs for the safety and efficiency benefits they provide. Data and information from operations at the key site will inform policies in the critical path to the FAA's BVLOS rulemaking, which will provide a regulatory approval path for UTM services to be used more broadly within the NAS. Key site operations will occur in Class G airspace at altitudes up to 400 feet AGL.

The FAA has also published an *Unmanned Aircraft Systems Traffic Management (UTM) Implementation Plan* (https://www.faa.gov/sites/faa.gov/files/PL_115-254_Sec376_UAS_Traffic_Management.pdf)

Regional Airports

In recent years, major air passenger carriers have been reducing operations at regional airports. AAM operators may find regional airports to be desirable locations for such things as air taxi services and cargo delivery airports.

Positive Impacts:

- **Increased Traffic:** AAM could revitalize underused regional airports by providing new connections and routes. Passengers could bypass congested hubs for shorter trips on eVTOLs, departing and arriving at these regional airports. This could lead to more flights and potentially increased revenue for the airports.
- **Accessibility Boost:** AAM aircraft do not require long runways, making them suitable for smaller regional airports. This could improve connectivity for remote or underserved communities, bringing them closer to major centers.
- **Noise Reduction:** Since AAM vehicles are electric, they are quieter than traditional airplanes. This could be a major benefit for communities around regional airports.

More FAA related challenges and considerations:

- **Infrastructure Needs:** Regional airports may need to adapt their infrastructure to accommodate AAM operations. This could involve creating vertiports or landing pads specifically designed for eVTOLs.
- **Competition or Collaboration:** Depending on the range and capacity of AAM vehicles, they could potentially compete with some existing regional routes. However, there's also a chance for collaboration, with regional airports becoming hubs for feeder flights to and from major AAM destinations.

- **Uncertainties Remain:** AAM is still an emerging technology. The full impact on regional airports will depend on factors like regulations, operational costs, and public adoption of these new vehicles.

In the initial stages, regional airports are more likely to service **cargo** rather than passenger AAM aircraft for a few reasons:

- **Infrastructure:** Most existing regional airports already have the infrastructure to handle cargo, including dedicated cargo terminals and handling equipment. Adapting these facilities for smaller cargo AAMs might be easier than modifying passenger terminals for eVTOLs.
- **Security Requirements:** Passenger AAMs would likely require additional security measures similar to traditional passenger flights. Cargo AAMs, on the other hand, might have less stringent security protocols.
- **Range and Capacity:** Early AAM vehicles might have a shorter range and lower cargo capacity compared to passenger versions. This would make them more suitable for regional cargo delivery within a limited radius, leveraging the existing network of regional airports.

However, this trend could change in the future:

- **Passenger AAM Development:** As passenger AAM technology advances, offering longer range and higher capacity, regional airports might invest in infrastructure to accommodate them. This could create a new wave of passenger travel options through regional airports.
- **Hybrid Model:** Some regional airports might become hubs for both cargo and passenger AAM operations, depending on local needs and infrastructure capabilities.

Overall, the impact of AAM on regional airports is likely to be positive in the long run. By embracing this new technology and adapting their infrastructure, regional airports have the potential to become key players in the future of transportation.

AAM eVTOL Vertiports

AAM aircraft will require appropriately equipped locations for operations. The FAA released its *Vertiport Engineering Brief 105* in 2022 (https://www.faa.gov/sites/faa.gov/files/eb-105-vertiports.pdf) detailing the requirements for construction of manned eVTOL AAM vertiports (https://www.faa.gov/newsroom/faa-releases-vertiport-design-standards-support-safe-integration-advanced-air-mobility). Such facilities are the equivalent of heliports for helicopters but address the specific needs of electric aircraft such as eVTOL air taxis with multiple rotors. Battery charging stations will be required at these locations. The FAA is working on guidance for unmanned drone vertiports as part of the AAM program.

Current Activities in Ohio

Ohio is recognized as a national leader in preparing for AAM. There are multiple initiatives around the state that support this hypothesis.

- JobsOhio is facilitating local AAM strategies in the 5 economic development regions across the state. Each region is customizing their AAM strategy based on local interests, resources, and objectives, while JobsOhio provides awareness of state and national activities.

- The Northeast Ohio Flight Information Exchange (NEOFIX) in Cuyahoga County. NEOFIX is local infrastructure that uses an open interface to allow UAS Service Suppliers and makers of ground control software to connect to a public data source to automatically subscribe to, collect, and use NEOFIX data to understand ground conditions, ground rules, and who else is flying in the area. NEOFIX is administered by Baldwin Wallace University (BW) in Berea, Ohio on behalf of Cuyahoga County, Ohio. The data in NEOFIX is owned and managed by BW as a public asset for the people of Cuyahoga County. NEOFIX provides authoritative state and local data sharing for local and state agencies, to UAS Service Suppliers (USS), and to Uncrewed Aerial Systems (UAS) and Advanced Aerial Mobility (AAM) operators.

- The Ohio Department of Transportation UAS Center provides a statewide coordination resource for drone and AAM integration activities, including publishing the Ohio UAS Framework and guidance for UAS Traffic Management implementations. The Ohio UAS Center also coordinates access to SkyVision, a ground-based detect-and-avoid radar system at the Springfield-Beckley Municipal Airport, through a partnership with AFRL. The system uses three existing FAA active radars to track piloted aircraft, minimizing the risk of collision for drone operators.

- The industry base in Ohio for supporting AAM growth is also strong.

    - Joby Aviation has selected Dayton for a manufacturing hub.
    - The northeast Ohio aerospace manufacturing industry is well prepared to the support the supply chain needs of the community with original equipment components and aftermarket parts for maintenance and repair.
    - GE Aerospace employs over 9,000 people in the Cincinnati region manufacturing commercial aircraft engines. This workforce demonstrates Ohio's ability to support an industry.
    - Sierra Nevada Corporation is opening a new MRO facility in Dayton.
    - NASA Glenn Research Center, the Air Force Research Laboratory at Wright Patterson Air Force Base, and the aerospace research programs at the universities across the state provide a strong aviation research community.
    - America Makes is the nation's leading public-private partnership for additive manufacturing technology and education, based in Youngstown. This is a unique resource that is well positioned to support the growing AAM sector built on advanced manufacturing techniques to produce light-weight parts that are made in America.

- Manufacturing Works in Cleveland has supported the manufacturing community in the region for more than 30 years. For the last 4 years they

have dedicated resources to growing the AAM capabilities in the area through strategic planning, membership engagement, and educational initiatives. In 2023 Manufacturing Works identified the following steps as the Roadmap for AAM implementation in the region:

Figure 1: AAM Roadmap Steps

Collectively, these initiatives and other programs around the state over the last 10 years provide an informed citizenship and business environment for embracing the potential impacts of AAM. Expanding aerial transportation in the state, and eventually the country, requires all of these activities to align and progress to a common goal. Manufacturing provides the aircraft and components for flying; colleges and universities provide the workforce of engineers, technicians, business professionals, and scientists who will build and use the services provided by AAM; federal, state, and local governments will provide the regulatory environment for managing the operations and recognizing standards for safety and access. Ultimately, society embraces AAM as an alternative form of transportation when it is affordable, reliable, safe, available, and beneficial. Each of these qualities is a spectrum by itself, as affordable to a major corporate CEO may not mean the same as affordable to a family of 4 in a rural farming community. Ohio is well prepared to support the adoption of AAM by supplying the workforce that builds the technology, by letting the local governments collaborate to provide the infrastructure and innovation ecosystems that open the skies, and encouraging the businesses in the state to utilize AAM services for routine operations.

Northeast Ohio AAM Operations

The FAA has outlined a national UAS integration plan in broad strokes, but how might such a plan be implemented in northeast Ohio? Northeast Ohio is a mixture of many types of geography, including lake coastlines, large cities, small villages, suburbs, farms, and large and small airports, and many other features.

What sort of Advanced Air Mobility airspace regulation might be required to manage such a diverse area? What sort of AAM operations might be expected to take place in such an area? One can envision a need for air taxis from and to various locations, air rescue ambulances similar to helicopters but perhaps with a smaller footprint, package delivery services, and other needs yet to be discovered. Human piloted aircraft like AAM air taxis and similar aircraft will probably be regulated by the FAA like any other manned aircraft. However, unmanned remotely piloted or autonomous drone aircraft will likely fall under other regulations. At this point in time, passenger carrying AAM aircraft are a few years away from FAA airworthiness certification. There are a few companies building large autonomous cargo delivery aircraft, but they are mostly in the prototype stage. Small autonomous drones used for observational purposes and some special purpose operations like mapping and crop spraying drones are widespread, but small package carrying drones are just catching on is some instances. It is likely that we might see small package carrying drones in Ohio as the first instance of AAM aircraft in this area.

AAM Operations in Rural Areas

Benefits of Rural Area Operations: Rural areas in some ways are ideal locations to fly aircraft, whether manned or unmanned. Conventional aircraft require runways often several thousand feet long for takeoff and landing. The size of the aircraft means that large hangar facilities are required for aircraft maintenance and storage. Airfields generally are devoid of obstacles for aircraft to fly into. For package delivery, there are often large open spaces for drones to deposit packages without fear of hitting obstacles or having packages or aircraft stolen. There are also there are potential applications for drone delivery specifically in rural areas:

- **Medical Supplies:** Drone delivery could be beneficial for delivering urgent medical supplies to remote locations or areas with limited access to traditional transportation. For example, Zipline has created a niche market for itself by delivering blood and medical supplies in Rwanda: https://www.youtube.com/watch?v=nnKnMgWy_tM

- **Specialized Deliveries:** Drones might be used for niche applications like delivering specific parts or supplies to farms or industrial locations in rural areas.
- **Some large UAS cargo aircraft are in development:**
- Mighty Fly plans to carry 500 lb cargo with a 600 mile delivery range.
- https://www.iotworldtoday.com/transportation-logistics/cargo-drone-company-receives-faa-flight-corridor-approval#close-modal and
- https://www.youtube.com/watch?v=5iHL8qp9ZEs

Challenges in Rural Areas:

- **Sparse Population:** Rural areas have a scattered population, making it less efficient to constantly have drones flying long distances between deliveries.
- **Limited Infrastructure:** Rural areas might lack the readily available infrastructure like fulfillment centers or landing pads needed to support a large-scale drone delivery network.
- **Regulation and Acceptance:** Regulations regarding drone flights over private property might be more complex in rural areas compared to controlled airspace in cities. Gaining public acceptance for frequent drone traffic could be another hurdle.
- **Costs:** Related to the issue of sparse population in rural areas is the nature of drone deliveries, which is typically one package per drone and one drone per human pilot. According to a study by McKinsey, a drone delivering a single package is estimated to have a direct operating cost of approximately $13.50, which is actually higher than using electric cars and vans doing the same single delivery (https://www.emarketer.com/insights/drone-delivery-services/). Most of that cost goes to salary to pay the pilot. https://www.diva-portal.org/smash/get/diva2:1441695/FULLTEXT01.pdf

  However, these cost issues could change if the regulatory environment were to better support drone delivery. The single most important factor driving up the cost of drone delivery right now is labor. In the McKinsey model, this factor accounts for 95% of the cost. And that's because, in most countries, regulations state that a pilot can only operate and monitor only

one drone at a time. Many regions also require a visual observer to monitor the airspace in which the drone operates. Therefore, if drones were to become truly cost-competitive, the number of drones per operator would need to increase greatly. This means that technology will also need to advance significantly in terms of drone autonomy, sense-and-avoid solutions, and uncrewed traffic management systems. Once these innovations are in place, regulations will need to evolve, enabling larger numbers of drones per operator. More specifically, a single operator may need to manage as many as 20 drones in a densely used airspace to gain potential cost advantages from drone delivery. "If drone operators can eventually manage 20 drones simultaneously, our analysis, using reasonable assumptions, suggests that a single package delivery will cost about $1.50 to $2," the McKinsey report says. This is in line with the per-package cost for an electric car delivering five packages and any type of van delivering 100 packages in a milk-run format when a driver delivers all packages in a single trip — a process that is not always feasible."

https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/future-air-mobility-blog/commercial-drone-deliveries-are-demonstrating-continued-momentum-in-2023

- **Amazon:** One rural delivery company's drone experience was as follows. Amazon announced on April 24, 2024, that it was dismantling one of its two founding drone hubs in historic Lockeford, CA, after a decade of failing to make significant aerial deliveries from the site. The company says the move is part of a strategic transition away from isolated rural areas toward more densely populated suburbs and will set the stage for a major expansion of its drone service with the help of new UAV prototype, the MK30, which is quieter and faster but also more durable and efficient than past drones. Amazon will continue to experiment with deliveries from its second hub site in College Station, TX, where the company claims it has already made thousands of deliveries since formally launching operations in November 2022. Industry experts have cast doubt on those numbers, saying the company's Prime Air service has reached barely several hundred customers, due to persistent safety and performance failures as well as delivery delays due to strict FAA protocols limiting the scope and duration of Prime Air

flights. https://dronevideos.com/amazons-prime-air-drone-service-another-painful-but-promising-transition/

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- https://www.youtube.com/watch?v=5iHL8qp9ZEs

Government Support of Rural Drone Delivery Systems: Various government agencies are sponsoring programs to spur drone applications in rural areas. For example, the University of North Dakota is participating in a U.S. Department of Transportation grant to use drones to deliver medicines and medical supplies for members of the Three Affiliated Tribes in western North Dakota. (https://blogs.und.edu/press-releases/2023/03/federal-grant-to-support-medicine-deliveries-by-drone/). The undertaking, called MHA Nation Drone

Project: Planning and Protocol Development, was first announced on March 15, in a release from Sen. Kevin Cramer, R-N.D. The project makes available nearly $2 million to conduct demonstration projects focused on improving the efficiency of transporting medicines. The grant is part of a larger DOT initiative called the Strengthening Mobility and Revolutionizing Transportation (SMART) Grants Program (https://www.transportation.gov/grants/SMART), which was created after the passing of the Bipartisan Infrastructure Law (BIL). The BIL authorized $100 million for state, local and tribal governments to conduct demonstration projects focused on advanced smart city or community technologies and systems to improve transportation efficiency and safety. The project was funded due to the focus on using technology interventions to solve real-world challenges facing communities today including improving access to life saving medications in remote tribal lands.

AAM Operations in suburban Areas. Higher up on the population density scale would be individual family homes with adequate yard space for package delivery. Several small package drone delivery companies are working in that space now. At this point in time, such delivery areas might be considered the low hanging fruit for such companies. Next up for areas with high population density and high potential profits are suburban area with large apartment complexes. These places have limited space for drone package delivery in the vicinity of the apartment dweller's home. Yard space is minimal, and the apartments are generally surrounded by parking lots. Drone delivery companies may have to arrange specific operations with the apartment complex management.

AAM Operations in Urban Areas. The areas with the highest potential profits are apartment buildings in large cities. Such building are typically flat roofed and is some ways are ideal delivery locations for drones due to landing zone proximity to large numbers of building occupants. Older building may have limited or no access to the roof, but new or newer buildings might be adapted to have drone package delivery spots. Delivery companies might be able to work out agreements with building management to have someone pickup up delivered packages on the roof, possibly for a fee. Such operations may require advance planning to address safety and engineering issues.

Dense Urban Population:

- **Higher Delivery Concentration:** Cities have a high population density, meaning more deliveries can be made in a smaller area. This translates to increased efficiency for drone delivery services.
- **Shorter Distances:** Distances between delivery points tend to be shorter in urban areas compared to rural locations. This is crucial for drone range limitations, especially for battery-powered models.

Existing Infrastructure:

- **Customer Base:** Urban areas concentrate a larger customer base, making them a more attractive market for drone delivery companies. The potential customer volume justifies the investment in infrastructure and operations.
- **Fulfillment Centers:** Many large cities already have established fulfillment centers for e-commerce giants. These locations can serve as hubs for drone deliveries, reducing the need for extensive new infrastructure development.

Urban Drone Delivery Challenges. Urban drone delivery has the potential to revolutionize city living. As technology advances and regulations are ironed out, drones might be found flying through urban skies, delivering packages efficiently and safely. However, there are several issues a drone package delivery company might face in a large city:

Air traffic congestion: Imagine a sky filled with delivery drones. Coordinating safe flight paths to avoid collisions with other drones, manned aircraft, and even birds could be a logistical nightmare.

Dense urban environment: Skyscrapers and power lines can disrupt signals and create no-fly zones. Landing zones become scarce with limited rooftop space and busy streets.

Safety concerns: A malfunctioning drone raining down a package on a pedestrian is a scary possibility. Public anxiety about malfunctions and privacy violations due to constant drone surveillance needs to be addressed as well.

Regulation and Permits: Cities are still grappling with how to regulate drone traffic. Obtaining permits to operate a large-scale drone delivery service can be a hurdle.

Weather: High winds, rain, and snow can ground drones, causing delays and frustrating customers who were expecting speedy deliveries. In general, small UAS aircraft do not operate during inclement weather. Although typically electric powered, small UAS aircraft still require ventilation to cool motors, electronic speed controllers, and other parts. Openings to permit ventilation also allow moisture to enter the aircraft if precipitation is in the air, which can short out electrical systems and give faulty readings to instruments. Rain, snow, and ice on propellers can reduce their efficiency. All-weather UAS aircraft are under development. Innovative weather prediction systems are also under development to better allow UAS aircraft to meet operational requirements.

Limited payload capacity: Small drones cannot carry heavy packages, so they might not be suitable for all deliveries.

Security risks: Packages dangling from the sky by tethers to UAS aircraft could be tempting targets for thieves. Ensuring secure delivery methods is crucial.

Air traffic management:

- Dense airspace: Cities are crowded, not just on the ground but also in the air. Helicopters and private planes could create a complex traffic environment for delivery drones to navigate safely.

- No fly zones: Certain areas in a city might have restrictions on drone flight, like around airports, government buildings, or sensitive infrastructure.

Safety and Security:

- Crowds and collisions: Large numbers of people mean a higher risk of collisions with pedestrians or objects during normal daily operations or large outdoor events.

• Security concerns: Valuable packages could be vulnerable to theft mid-air or after landing on rooftops, balconies, or sidewalk and lawn spaces.

Technical limitations:

• Weather conditions: Strong winds, rain, or snow can disrupt drone operations and impact safe flight.

• Battery life: Delivery drones need to efficiently navigate and carry packages within a limited battery life to be effective.

• Noise pollution: A large number of drones flying overhead could create noise disturbances for residents.

Regulations and Public Perception:

• Privacy concerns: People might be uncomfortable with drones flying over their homes and workplaces.

• Regulations: Air traffic control rules and regulations for drone delivery in urban areas are still under development.

• Small UAS Range Limitations: Small UAS aircraft have several factors limiting their effective range:

Main motor battery life: Small UAS aircraft (SUAS) batteries can provide flight times up to about 60 minutes.

GPS limitations. SUAS aircraft that are likely to fly package delivery routes will probably have GPS controlled autopilots. Flying between tall buildings may limit the GPS antenna's access to overhead satellite signals and reduce flight precision.

Manual mode. SUAS aircraft generally have a manual flight mode in case of autopilot failure. Manual mode would be controlled by a remote control radio and a human operator on the ground. Tall buildings may block the operator's visibility of the aircraft and also block the remote control radio signal to the aircraft resulting in loss of control. Radio transmitters on battery control have a range limit of about one half mile even in open areas under the best conditions

and may lose power and the ability to communicate with the aircraft after extended flight time.

Flight paths. SUAS aircraft are more likely to attempt to fly in straight line paths between their takeoff and destination points rather than more circuitous but perhaps less hazardous routes. Short range may necessitate more takeoff, landing, and charging points along a flight path. More of such points may be required around a city rather than one central location like a drone loading dock. Drone package delivery operators may have to negotiate takeoff, landing, and charging points around a city with various facility owners and managers to obtain landing access and to safely conduct operations with third party people in the area.

Delivery to Designated Urban Areas:

Overall, drone delivery in city apartment complexes is a complex issue with ongoing development. The future success of these solutions will depend on technological advancements, regulatory changes, and public acceptance.

As an example, the Zipline Type 2 delivery drone, also known as the P2 Zip, has a service radius of 10 miles, meaning it can deliver packages within a 10-mile circle around the launch site. However, its one-way flight range is actually greater, at 24 miles. This distinction is important because a round-trip delivery would not necessarily require flying the full 24 miles each way. Type 2 packages can weigh from 6-8 lbs. (https://www.flyzipline.com/about/zipline-fact-sheet)

Delivering packages to city apartment buildings with drones presents a unique challenge for drone delivery companies. Here are some proposed solutions:

- **Rooftop Landing Pads:** Equipping rooftops with designated landing pads for drones is an option. This would require collaboration with building management and ensuring safety protocols are in place.
- **Secure Lockers:** Drone companies might partner with apartment buildings to install secure lockers in lobbies or designated areas. Drones would deliver packages to these lockers, and residents would receive codes for access.

- **Identification and Verification:** Residents would likely need a secure system to identify themselves and authorize drone deliveries to their specific location.
- **Tethered Lowering System:** Drones could hover outside a resident's window and lower the package on a secure tether. This eliminates the need for a landing zone but might have limitations on package weight and wind conditions.
- **Direct Lowering with Release Mechanism:** Drones could descend to a safe distance and use a release mechanism to drop the package gently in a designated spot, like a balcony or a reinforced area.
- **Flight Path Planning:** Drone flights would need to be carefully planned to avoid collisions with buildings or people and comply with regulations regarding airspace in urban areas, which will require public sector infrastructure assets such as the Northeast Ohio Flight Information Exchange (NEOFIX)

Current Stage and Challenges:

City package delivery is still in the development or testing phase. Here are some hurdles that need to be overcome:

- **Regulation Approval:** Obtaining regulatory approval for drone flights in congested urban areas is a major challenge.
- **Infrastructure Investment:** Equipping buildings with landing pads or lockers requires investment and cooperation from property owners.
- **Public Acceptance:** Residents might have concerns about noise, privacy, and safety that need to be addressed.

City Rooftop Package Delivery Challenges

While some companies are exploring rooftop landing solutions like designated drone ports, vertiports, or landing pads, these add architectural complexity and require cooperation from building owners to operate securely. While seemingly ideal for drone deliveries, building tops in a large city present a unique set of challenges:

Accessibility**:** Not all rooftops are created equal. Many are uneven, cluttered with equipment (ventilation units, antennas), or have restricted access hatches. Landing safely and precisely on such surfaces could be tricky.

Weight restrictions**:** Buildings, especially older ones, might not be designed to handle the extra weight of a drone landing or the downward thrust from the rotors. Deliveries could be limited to very light packages.

Security concerns**:** Rooftop access in large buildings is often restricted for safety reasons. Granting delivery drones access could create security vulnerabilities. Delivered packages would require a chain of custody system so that delivered packages are not picked up by the wrong people.

Legal restrictions**:** Building code regulations might prohibit drone landings on rooftops due to safety concerns or noise pollution.

Line of sight**:** For safe and reliable landings, drones generally require a clear line of sight to the landing zone. Tall buildings and surrounding structures can easily block this line of sight. Drone based video and sensors like LiDAR might be required to locate appropriate landing zones.

Weather impact**:** High winds can be especially dangerous for drone landings on exposed rooftops. Deliveries might need to be cancelled during bad weather.

Privacy issues**:** Residents might not appreciate constant drone traffic over their buildings, raising privacy concerns about surveillance.

Examples of pilot programs for drone deliveries in urban areas:

- **UPS** delivered medical supplies by drone to a hospital in Raleigh, North Carolina https://about.ups.com/us/en/our-stories/innovation-driven/drone-covid-vaccine-deliveries.html
- **Flirtey** conducted drone delivery trials in partnership with Domino's in various locations, including Reykjavik, Iceland https://www.cnn.com/videos/world/2024/01/15/iceland-volcano-drone-burning-homes-cnntm-contd-vpx.cnn

- **Wing:** Owned by Alphabet (Google's parent company), Wing has conducted successful trials in suburban areas and even received FAA approval for commercial drone delivery in certain regions https://wing.com/.

  The latest Wing aircraft complements Wing's existing fleet of commercially operational aircraft, which carry about 2.5 pounds of payload. This new aircraft will make it even easier for customers to get what they need, when they want it. The new aircraft has the same round-trip range of 12 miles and can cruise approximately 65 miles per hour, all while carrying a standard cardboard delivery box with a payload up to five pounds. (https://blog.wing.com/2024/01/customer-demand-and-wings-aircraft.html)

- **Flytrex:** This company focuses on backyard deliveries in select US suburbs, offering restaurant meals and other goods within a short timeframe https://www.flytrex.com/.

  https://www.youtube.com/watch?v=Nq0Yumt_5YA

  https://www.youtube.com/watch?v=m9YxEj0t3aU

- **Manna Drone Delivery** https://www.youtube.com/watch?v=JCnpxmhWRuw
- **Zipline** https://www.youtube.com/watch?v=LblbC70vx-U
- **Amazon Prime Air:** Though currently limited, Amazon has been testing drone delivery through Prime Air in a few locations https://www.aboutamazon.com/news/transportation/amazon-prime-air-drone-delivery-mk30-photos.
- **Pharmaceutical Deliveries**
- Delivery of pharmaceuticals may be one of the best potential uses of drone package delivery. Prescription and over-the-counter drugs are generally intended for a single patient and come in small, light weight containers that are easily transported by drones. The cost of drone delivery would often be transparent to the recipient, since drug costs are often covered by insurance. Some medical organizations already have drone delivery

programs and others like the Cleveland Clinic have them in the planning stage (https://www.michiganmedicine.org/news-release/michigan-medicine-deploy-ziplines-drone-service-delivery-patient-prescriptions; https://www.flyzipline.com/about/zipline-fact-sheet).

One of the factors driving the need for timely drone delivery of pharmaceuticals is the fact that some diseases are very dependent on ready availability of drugs. Such diseases and their requisite medications include:

- **Infectious diseases:** Antibiotics, antivirals, and antiparasitics are essential for treating infectious diseases caused by bacteria, viruses, and parasites. Without these medications, these diseases can progress rapidly and become life-threatening.
- **Chronic diseases:** Many chronic diseases, such as diabetes, high blood pressure, heart failure, and asthma, require ongoing medication to manage symptoms and prevent complications. If these medications are not readily available, it can lead to a worsening of the condition and a higher risk of serious health problems.
- **Autoimmune diseases:** These conditions occur when the body's immune system attacks healthy tissues. Medications, such as immunosuppressants, can help to control the immune response and prevent further damage. Without these drugs, autoimmune diseases can cause significant disability and even death.
- **Cancer:** Chemotherapy, immunotherapy, and targeted therapies are all crucial for treating cancer. These medications can slow or stop the growth of cancer cells and improve survival rates. A lack of access to these drugs can significantly reduce the chances of successful cancer treatment.
- **Mental health conditions:** Medications play an important role in managing mental health conditions like depression, anxiety, and schizophrenia. These drugs can help to improve symptoms and allow people with mental illness to live more functional lives.

Some of the most appropriate drugs for drone delivery could include:

- **Refill prescriptions for stable chronic conditions:** Medications for managing conditions like high blood pressure, asthma, or depression could be suitable if temperature control and security measures are addressed.
- **Emergency medications for allergies or minor injuries:** Epipens or inhalers could be delivered quickly in case of emergencies.
- **Vaccinations:** Drones have been successfully tested for delivering vaccines in some regions, especially for areas with limited medical access.

The kinds of patients that are served by a drone pharmaceutical delivery system and where they live can influence the design and logistics of such systems due to drone flight limitations:

Some patients with chronic diseases may choose to live in urban areas for these reasons:

- **Access to Specialists:** Cities typically have a higher concentration of specialists and medical facilities, offering a wider range of treatment options for complex chronic conditions.
- **Clinical Trials:** Urban areas often house research institutions and hospitals that conduct clinical trials for new medications and treatments, potentially providing earlier access for some patients.
- **Public Transit:** Good public transportation in cities can make it easier for people with limited mobility to access medical appointments and pharmacies.

Other patients with chronic diseases may choose to live in urban areas for these reasons:

- **Lower Cost of Living:** Suburbs can be more affordable than city centers, potentially making it easier for people with chronic diseases to manage healthcare costs alongside medication expenses.
- **Lower Stress Levels:** Studies suggest that a slower pace of life and lower population density in suburbs might contribute to lower stress levels, which can be beneficial for some chronic conditions.

- **Safer Environment:** Suburbs may offer a safer environment for those with chronic illnesses that make them more susceptible to infections, depending on the specific disease.

The availability of suitable drugs may determine the kinds of illnesses which a pharmaceutical company is able to support. There are also other factors to consider when determining which drugs would be most suitable for drone delivery:

Drug Characteristics:

- **Temperature Sensitivity:**
  - Medications that require strict temperature control (e.g., insulin) might not be ideal for drone delivery unless the drones have built-in temperature-controlled compartments.
- **Shelf Life:**
  - Drugs with a short shelf life might not be suitable for drone delivery if long flight times or delays are possible.
- **Fragility:**
  - Highly fragile medications or those in delicate packaging could be susceptible to damage during drone transport.

Delivery Considerations:

- **Urgency of Need:**
  - Life-saving medications or those needed to manage critical conditions might be prioritized for drone delivery due to the potential speed advantage.
- **Weight and Size:**
  - Drones currently have limitations on payload capacity and range. Lighter and smaller medications would be more practical for drone delivery initially.
- **Security Concerns:**
  - Narcotics or other controlled substances would require robust security measures throughout the drone delivery process. For

example, Michigan Medicine will not deliver narcotics or other controlled substances by drone.

It is important to note that drone delivery regulations are still evolving, and specific requirements for medication transport might vary. As the technology matures and regulations adapt, the range of drugs suitable for drone delivery is likely to expand.

Full Scale Autonomous Delivery Aircraft. Commercial cargo drones coming on the scene now, such as those the size of manned General Aviation aircraft, would initially operate out of primary and regional airports, with final delivery of cargo by truck or smaller drone aircraft. Several start-up companies are now entering that space and eyeing the Cleveland region for operational partnerships. This could be a boon to small regional airports which have struggled in recent years due airlines ending service at municipal airports with low passenger traffic.

Sensor alternatives for Package Delivery Drones. The FAA does not explicitly recommend specific sensor types for delivery drones, as their regulations and proposed guidelines focus on performance-based criteria for safe operation in the NAS. This means drone manufacturers have some flexibility in choosing sensor payloads as long as they can demonstrate the drone's ability to safely perform its tasks. Below are alternative sensor payload types that may be used by delivery drones. These are general categories, and the specific sensor configuration will depend on factors such as drone size and payload capacity, operating environment (urban vs. rural), and delivery range and complexity. Different sensor types provide specific data for drone operations. Navigational sensors support safe flights and aircraft control. Sensors for situational awareness provide obstacle detection, traffic detection, weather information, and localized mapping for autonomous navigation.

- **Navigation Sensors:**
    - **GNSS (Global Navigation Satellite System):** This is essential for basic navigation, allowing the drone to determine its position using satellite signals.

- **Inertial Measurement Unit (IMU):** An IMU senses the drone's motion and orientation, providing data on acceleration, rotation, and tilt, which is crucial for stable flight control.

- **Obstacle Detection and Avoidance Sensors:**
  - **Electro-optical cameras (EO cameras):** As mentioned previously, these provide high-resolution visual data for obstacle detection and path planning.
  - **Radar:** While not ubiquitous yet or available for small drones, onboard radar sensors can offer 360-degree obstacle detection in low-visibility conditions or complex environments.
  - **LiDAR (Light Detection and Ranging):** As discussed earlier, LiDAR creates detailed 3D maps of the surroundings, aiding in obstacle avoidance and safe navigation, particularly during landing.
- **Additional Sensors (depending on application):**
  - **Barometer:** Provides data on air pressure which can be important for altitude control.
  - **Infrared (IR) camera:** While not essential for all situations, IR can be helpful for nighttime operations or low-light conditions.

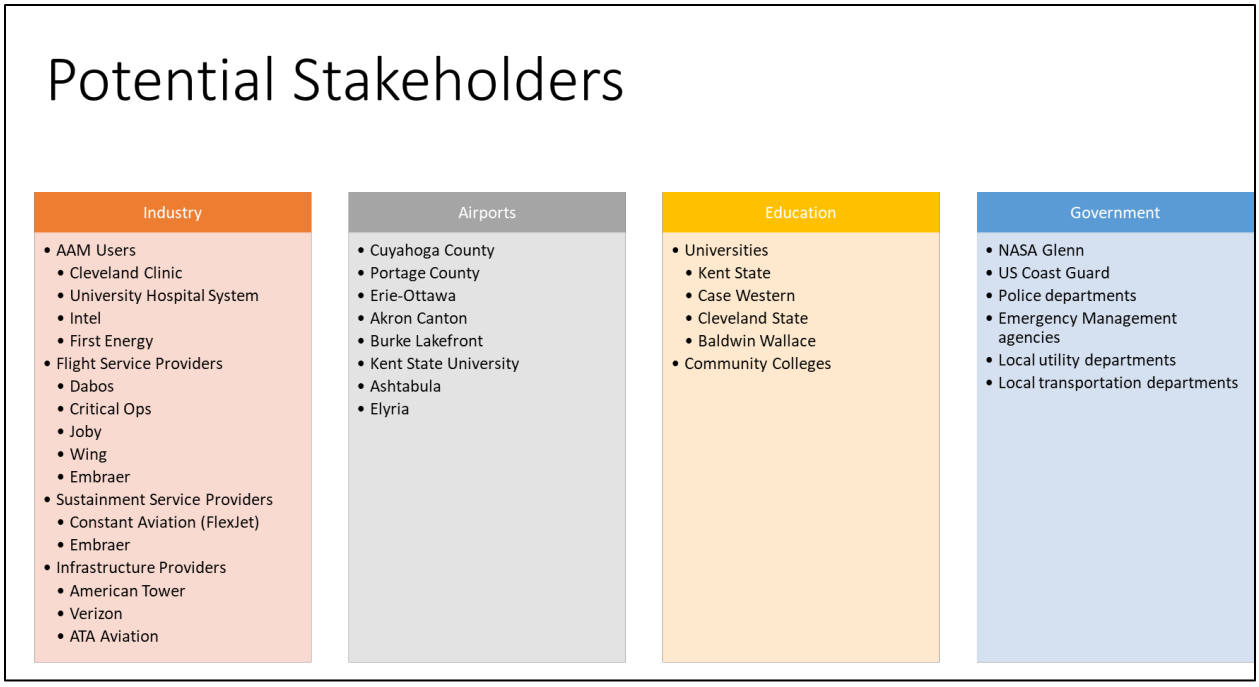
The FAA has published several references on the topic of drone sensors:

https://www.faa.gov/sites/faa.gov/files/uas/resources/policy_library/2019_UAS_Civil_Integration_Roadmap_third_edition.pdf

https://www.faa.gov/uas/advanced_operations/package_delivery_drone

(https://www.faa.gov/sites/faa.gov/files/uas/resources/policy_library/2019_UAS_Civil_Integration_Roadmap_third_edition.pdf).

Priority of airspace utilization will always be afforded to manned aircraft operations in the area. Due to the proximity of Burke Lake Front Airport and Hopkins International Airport, special efforts will be required to avoid interference with manned aircraft operations in the Cleveland area. Cooperation with all airports in the region to respect drone operation in the DAMS service area will be sought.



Conclusion

The commercial use of autonomous aircraft is an evolving environment. The FAA has various studies on-going to provide a safe and practical system for operating these aircraft within the National Airspace System. This white paper has sought to highlight some of the governmental and commercial aspects of bringing autonomous aircraft operations to northeast Ohio. This paper outlines the technology, policy, and operational complexities of integrating autonomous aircraft into northeast Ohio airspace for commercial small UAS operations. There are multiple ongoing initiatives in the Cleveland area to support current operations while also preparing to scale through increased utilization of drones in the region and across the state.

TAB 2

Northern Ohio Leading Commercial Advanced Air Mobility (CAAM) Critical Infrastructure Development

Briefing Purpose

Establishing the necessary role and policy support of the state legislature and the Administration in the public private partnership for Ohio's Commercial Advanced Air Mobility (CAAM) critical infrastructure development.

Introduction

The Federal Aviation Administration (FAA) designation of AAM is as an umbrella term for aircraft that are likely highly automated and electric. These aircraft are often referred to as air taxis or electric Vertical Takeoff and Landing (eVTOL) aircraft. They are also more commonly known as drones whose rising usage is fast occurring for commercial and medical delivery, cargo, public safety, emergency response and recreational purposes.

Ohio is a "first-in" adopter of *Commercial* Advanced Air Mobility (CAAM) Critical Infrastructure. One sign for this stature is the investment Cuyahoga County has made in establishing the Northeast Ohio Flight Information Exchange (NEOFIX).

The NEOFIX is a public-private partnership initiative of Baldwin Wallace University with its partner Advanced Technology Applications (ATA, LLC) of Virginia. The NEOFIX is vital technology infrastructure necessary to promote a friendly setting for drone use, repair, manufacturing and assembly industry and jobs development.

Seed-funded by Cuyahoga County District 2 to stimulate business development in the region immediately adjacent to NASA Glenn Research Center, Cleveland Hopkins International Airport and the recently formed Aerozone District, NEOFIX is a program for local government and public safety agencies to post information for each other and drone operators which keep the airspace open, secure, and safe.

The NEOFIX platform allows information sharing in compliance with the Federal Aviation Administration (FAA) and U.S. Homeland Security regulations. Datasets feature critical infrastructure and real-time flight operations while respecting municipal operational security, privacy requirements, public safety, and emergency preparedness practices. Such capabilities empower AAM, ultimately leading to industry adoption and job creation, replicable, throughout Ohio's 88 counties.

The platform may be viewed via: https://bw-centers-tech-partnerships.org/neofix-overview/. The free direct public access site can be found via: https://oh-fix.com/index.html.

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Commercial Advanced Air Mobility (CAAM)

Commercial Advanced Air Mobility (CAAM) represents a rapidly growing and transformative market poised to revolutionize various business and public sectors. With its innovative aerial transportation solutions, CAAM has the potential to reshape e-commerce by enabling swift and efficient last-mile deliveries.

Moreover, cargo transport could experience a significant boost, streamlining supply chains and reducing logistical challenges.

In emergency response scenarios, CAAM's agility and speed could save crucial time and lives, enhancing disaster relief efforts. Furthermore, the burgeoning CAAM industry is set to create a plethora of job opportunities, from skilled pilots and technicians to support personnel, fueling economic growth and development. As this promising sector continues to evolve, its far-reaching impacts are anticipated to transcend traditional boundaries, offering society a glimpse of a more interconnected and efficient future.

The NEOFIX is a tangible step in creating commercial AAM with leading North and Northeastern Ohio regional stakeholders that include the nonprofit intermediary Manufacturing Works (MW) and Kent State University.

The potential is driving innovation by companies around the globe and Ohio's CAAM leadership role is also recognized by other states. For example, NEOFIX – the only regional participant among other statewide actors - is a founding participant in the growing collaborative of states that include Virginia, Utah, Pennsylvania, Oklahoma, New Jersey, California and Alaska.

Public Private Partnership (PPP)

Northern Ohio, led by Baldwin Wallace University (BW) and Manufacturing Works (MW), are methodically identifying, and convening private stakeholders and local, state and federal officials to advance publicly owned infrastructure for CAAM. The strategic PPP alliance will guide the future "traffic in the sky," including physical radars, ground based sensors for weather, motion and other necessary drone ready purposes. Safe operations infrastructure accounts for vehicle deconfliction, air traffic data, safety regulations and shared public-data governance.

NEOFIX is public infrastructure - created as a PPP – to set the conditions for "traffic in the sky" which cannot rely on any single company or government action. The coordination of physical radar, vehicle deconfliction, air traffic data, and safety regulations require an ecosystem of partners and stakeholders working together. The NEOFIX is organized to model local infrastructure design to inform and advise the FAA, which looks to each AAM community on how best to organize and implement Federal aviation and airspace policies. The PPP collaboration process started in 2023 stimulated by Cuyahoga County District 2 ARPA funds by defining Northeast Ohio's regionals assets, bringing industry and subject matter experts to the table.

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The vision for future CAAM development in Northern Ohio is predicated on these key performance indicators:

- BW and Manufacturing Works (MW) will establish a PPP as a structure for collaboration, cooperation, acquisition, integration, and information sharing. Manufacturing Works will serve as the administrator of the partnership. Partners will be recruited from industry, local communities, state agencies, academia, and national leaders. Invested financial partners currently include Cuyahoga County, Manufacturing Works, Baldwin Wallace University and Kent State University.
- BW and MW will integrate and seek investment from private sector partners that are experts in the field of CAAM. These private sector partners are both new to Ohio and where existing proposing expanded presence as their operations increase. These private companies include Collins Aerospace, OneSky, Crown Castle, Sprite, First Energy, Pierce Aerospace, Cal Analytics, Ecodyne, Michael Best Consultants and Saab.
- NASA Glenn has been integral to the project development offering communication support and potentially the use of Armstrong as a test site.
- **Investment by the State of Ohio over the next five years is seminal to private investment to drive private pay to fiscal sustainability of the CAAM infrastructure.**

Incremental Steps to Achieve CAAM

The ***first phase*** was the establishment of NEOFIX in 2023, a critical infrastructure platform. Datasets and members are being added daily to advance the platform. This project has advanced under the work of BW's Technology Transfer initiative with its partner ATA, LLC of Virginia.

The ***second phase*** includes crewed and uncrewed radar and communication testing between Portage, Akron Fulton, and KSU airports. Similar yet smaller demonstrations will then occur at the NASA Armstrong Facility. Partners will provide business services (e.g., inspections, package delivery, etc.) and data services for airspace deconfliction and awareness. These tests engage leaders in CAAM, demonstrating the use case for PPP, data for analysis, and policy recommendations, creating opportunities to open the skies to Electric Vertical Take-Off and Landing (eVTOL) and other scalable energy solutions.

The NEOFIX project is the first step toward CAAM implementation and cargo delivery in Northeast Ohio. Partners will use NEOFIX to provide business services (inspections, package delivery) that accommodate the FAA's regulations referred to by Part 107 UAS operations. Part 107 refers to the FAA rules for small, unmanned aircraft systems (UAS), or "drone," operations concerning a broad spectrum of commercial and government uses for drones weighing less than 55 pounds).

Other partners will provide data services for airspace deconfliction and awareness that will support current flight operations and provide further analysis and advisory for FAA drawing

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from local officials responsible for opening the skies to eVTOL and other scalable energy opportunities.

The ***third phase*** explores air-taxi services and regional connections for supply chain distribution for the polymer industry and medical supplies as just two examples of business chains currently engaged with the NEOFIX. Over time, the network and infrastructure expansion connect to other parts of the state, nearby regions, and the national system. This introduces business models, including user fees and adopted standard operating procedures and policies.

As these development programs are implemented, the NEOFIX PPP will be engaging local, county, state and federal authorities on their impact while working with entities to determine policy considerations for future funding, performance and advancement requirements.

Legislation and public sector support

Achieving the goals for the CAAM infrastructure requires the buy-in of public and private stakeholders. First-in public sector funding is essential to stimulate private investment and the development of a user fee schedule to pay for on-going operations of the NEOFIX and the statewide system.

Additionally, the statewide rollout for commercial AAM, stakeholder training and coordination among the 88 counties, development and coordination of comprehensive state policy on AAM for municipalities and their public safety, emergency preparedness and management, and of course coordination and facilitation with federal agencies such as the FAA, Homeland Security, the national guard just to name a few.

Call to Action

To achieve the vision for the CAAM infrastructure, it is crucial to garner binding support and active involvement from public and private stakeholders, including federal agencies like the FAA, Homeland Security, and the National Guard. Beyond the state legislature and Governor DeWine's office, Ohio actors include DNR, ODOT, JobsOhio, Department of Commerce, EPA, and HAZMAT to name just a few. *The initial focus should be securing public sector funding, as this will catalyze private investment in Ohio*. Moreover, creating a user fees schedule and implementing a collection dissemination system is essential for the sustainable development of NEOFIX and the statewide system.

Furthermore, there is a need for the statewide rollout of Commercial Advanced Air Mobility stakeholder training and coordination among the 88 counties. Target audiences include public and private stakeholders, and content covers public safety, emergency preparedness, and management.

We estimate this investment will require a five-year investment of $2 million per year from public and private support to set the conditions for a sustainable infrastructure necessary to drive the industry described in this briefing. We anticipate long-term sustainability to derive through a user fee system to be designed and implemented during the five-year term.

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