Concept of Operations

v1.0

Foundational Principles

Roles and Responsibilities

Scenarios and Operational Threads

Urban Air Mobility (UAM)

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U.S. Department
of Transportation
Federal Aviation Administration

Office of NextGen

800 Independence Ave., S.W.
Washington, DC 20591

June 26, 2020

Dear Reader:

We are pleased to share Version 1.0 of the Urban Air Mobility (UAM) Concept of Operations (ConOps) with our FAA, NASA, and Industry partners who participated in coordination activities in the summer of 2019 and the guided discussion session at NASA Ames Research Center (ARC) in February 2020. This ConOps documents the outcomes of the guided discussion and the joint concept development efforts we have undertaken to date.

UAM ConOps Version 1.0 is initial stage of work in progress and the concept will be continuing to mature and modified through ongoing Government and industry stakeholder collaboration. The results of those collaborative efforts will be integrated into a future editions of UAM ConOps, that provide a broader and more comprehensive vision of our shared partnership for UAM operations.

Sincerely,

Steve Bradford

Steve Bradford
Chief Scientist, Architecture & NextGen Development
Office of the Chief Scientist, ANG-3

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Executive Summary

The Federal Aviation Administration (FAA) NextGen Office developed this Concept of Operations for Urban Air Mobility (UAM) (ConOps 1.0) to describe the envisioned operational environment that supports the expected growth of flight operations in and around urban areas. UAM is a subset of the Advanced Air Mobility (AAM), a National Aeronautics and Space Administration (NASA), FAA, and industry initiative to develop an air transportation system that moves people and cargo between local, regional, intraregional, and urban places previously not served or underserved by aviation using revolutionary new aircraft. While AAM supports a wide range of passenger, cargo, and other operations within and between urban and rural environments, UAM focuses on the transition from the traditional management of air traffic operations to the future passenger or cargo-carrying air transportation services within an urban environment.

The envisioned future state for UAM operations includes increasing levels of autonomy and operational tempo across a range of environments including major metropolitan areas and the surrounding suburbs. As described in stakeholder sessions, the mature state operations will be achieved at scale through a crawl-walk-run approach, wherein:

1. Initial UAM operations are conducted using new vehicle types that have been certified to fly within the current regulatory and operational environment.
2. Higher tempo UAM operations are supported through regulatory evolution and UAM Corridors that leverage collaborative separation methodologies.
3. New operational rules and infrastructure facilitate highly automated traffic management enabling remotely piloted and autonomous vehicles to safely operate at increased operational tempos.

This document defines the UAM operating environment in the context of Air Traffic Management (ATM) and Unmanned Aircraft System (UAS) Traffic Management (UTM). This document presents the ATM vision to support initial UAM operations. UAM ConOps 1.0 does not prescribe specific solutions, detailed operational procedures, or implementation methods except as examples to support a fuller understanding of the elements associated with UAM operations.

The UAM ConOps implementation is an evolutionary approach and includes engagement with NASA and industry and community stakeholders. This version captures the combined thoughts of industry, NASA, and the FAA of how operations may be conducted in the future and is still in need of test, validation, and verification before becoming a more established description. Future versions of this concept will be developed to reflect the outcomes of analyses, trials, concept maturation, and collaboration that arise from these initial thoughts.

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Version History

Date	Revision	Version
6/26/2020	Baseline Document	1.0

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1 Introduction

1.1 Scope

Urban Air Mobility (UAM) enables highly automated, cooperative, passenger or cargo-carrying air transportation services in and around urban areas. UAM is a subset of the Advanced Air Mobility (AAM) concept under development by the National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA), and industry. While AAM supports operations moving people and cargo between local, regional, intraregional, and urban environments, UAM will focus on the urban and suburban environments. This Concept of Operations (ConOps) provides an initial, foundational perspective supporting the introduction and incorporation of UAM operations into the National Airspace System (NAS).

The goal is to provide a common frame of reference to support the FAA, NASA, industry, and other stakeholder discussions and decision-making with a shared understanding of the challenges, technologies, their potential, and examples of areas of applicability to the NAS. No solutions, specific implementation methods, or detailed operational procedures are described in this document except for example purposes (i.e., operational scenarios). This document will be further matured and updated as the concept undergoes validation, stakeholder engagement continues, and additional operational scenarios are developed.

As the initial UAM ConOps, this document represents a step along an evolution that introduces UAM operations, orients these operations in relation to other operations (e.g., existing NAS operations, Unmanned Aircraft System (UAS) Traffic Management (UTM) operations), identifies the range of automation and regulatory changes to support the operations, and describes a collaborative environment to support increasing density of operations. Each of these items is explored in this ConOps.

For this ConOps, consistent with industry expectations, UAM operations will include a Pilot in Command (PIC) onboard the UAM aircraft.

1.2 Document Organization

This ConOps is organized as follows:

Section 1 – Introduction – provides the scope and background for the ConOps

Section 2 – Overarching Principles and Assumptions

Section 3 – Evolution of UAM – describes how the operations described in the UAM ConOps fit into the larger evolution of UAM operations

Section 4 – UAM Operations – describes the operations within the scope of the UAM ConOps

Section 5 – Notional Architecture – describes the primary actors, functions, and data flows that support the UAM operations described in the UAM ConOps

Section 6 – UAM Use Cases – describes single thread operations that demonstrate the orchestration of UAM operations (Section 4) and the notional architecture (Section 5)

Section 7 – UAM Implementation – describes an evolutionary approach to implementation of UAM operations within scope of the UAM ConOps

Appendix A – Glossary

Appendix B – Acronyms

Appendix C – References

Appendix D – Helicopter Route Operations

1.3 Background

Each year, ground traffic increases resulting in longer commute times with significant economic costs. Americans spend an estimated 8.8 billion hours sitting in road traffic per year with an expected increase of 14 percent by 2023[1]. Figure 1-1 shows the general increasing trend of how many hours Americans have spent commuting[1].

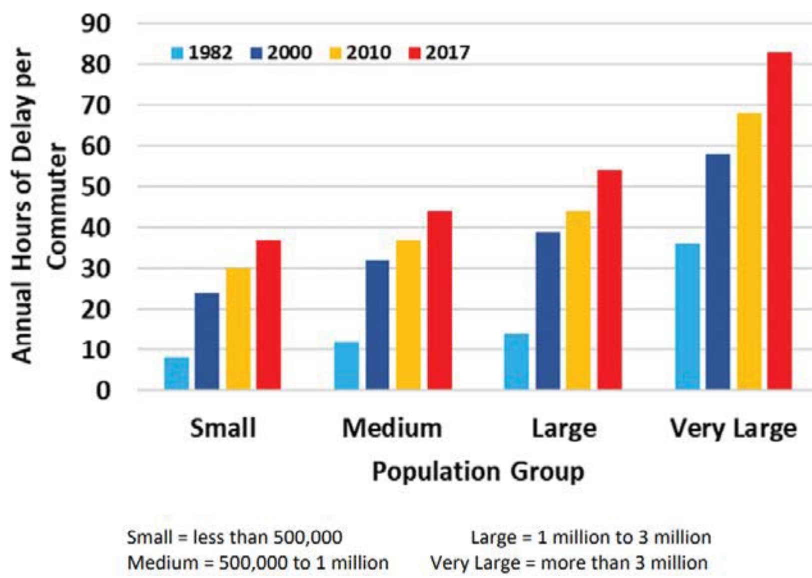

Figure 1-1: US Auto Commute Congestion Growth Trend

While the concept of urban-centered air transportation has existed for decades in limited availability in the form of conventional helicopter transportation, this has not been widely accessible due to high operational expense, service cost for the customer, and negative public response to noise and pollution. Recent technological advances have allowed the concept to evolve. Significant improvements in electrical energy storage and capacity will enable electrically powered aircraft that will reduce costs, reduce noise, and provide greater safety.

[1] Texas A&M Transportation Institute. (2019). *2019 Urban Mobility Report.* https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2019.pdf

1.3.1 Drivers for Change

For the UAM concept to mature to operational viability, understanding stakeholder business and operational needs is important for incorporation into, and understanding the impact to, the NAS. Accordingly, the FAA has collaborated with NASA and participated in the industry stakeholder engagements to identify the desired operations and environment for these aircraft.

With traffic and commute times on the ground increasing, there will be an increasing demand, and a market, for alternative transportation methods. With anticipated decreasing operational costs due to economic scaling, the volume of UAM operations may increase substantially. At present, the degree to which some, or all, of these UAM operations will require current Air Traffic Management (ATM) systems and services is undefined. To the degree that these operations require current ATM systems and services, the increasing number of UAM operations may soon challenge the current capabilities of the ATM infrastructure and Air Traffic Control (ATC) workforce resources. Solutions that extend beyond the current paradigm for manned aircraft operations to those that promote shared situational awareness and collaboration among operators are needed. As the FAA continues to mature the UAM concept, additional support systems for UAM operations may be introduced.

The introduction of the UAM concept presents new approaches to aviation which will allow a new class of operations to provide an alternative intermodal transportation method within urban areas where surface congestion causes significant travel delays. Several industry leaders and other stakeholders have already invested heavily in this new concept and technology with the goal of eventually being able to provide the public with personal transportation or cargo services. Personal transportation services may be scheduled, on demand, or part of intermodal transportation links within major urban areas.

Advances in technology have enabled detect-and-avoid (DAA) and other advances in operational capabilities. Cloud networks and mobile devices now support fleet management and customer interactions for on-demand service. Greater public acceptance of aircraft integrity and automation in the ride sharing economic model will also help enable increased UAM operations.

1.3.2 Aircraft Evolution

The industry vision involves incorporating new aircraft designs and systems technologies. Some of these new aircraft designs are anticipated to include vertical takeoff and landing (VTOL) capabilities that allow for operations between various locations (e.g., metropolitan commutes). Major aircraft innovations, mainly with the advancement of distributed electric propulsion (DEP) and development of electric VTOLs (eVTOLs), will potentially allow for these operations to be utilized more frequently and in more locations than are currently performed by conventional aircraft. Indications from industry manufacturers and operators are that initial operations will be flown with a PIC on board these VTOL aircraft with the potential of evolving to fully autonomous operations with remote PICs.

Leveraging economies of scale and investing heavily in mass-produced lightweight airframe structures that will enable lower-cost aircraft construction and increasingly automated flight operations may reduce pilot and associated operational costs. Lower operational costs may allow companies to make short-range air transportation more accessible to the public which is expected to eventually lead to large numbers of daily operations.

1.4 Operating Environment Perspectives

NAS operating environments are the airspaces, types of operations, regulations, and procedures to support an operation. Table 1 shows a high-level comparison of UAM, UTM, and ATM environments. UAM operations occur within the context of the UAM environment defined by this ConOps (UAM ConOps 1.0). UAM aircraft operate between UAM aerodromes ("aerodromes") within UAM Corridors – a performance-based airspace of defined dimensions in which aircraft abide by UAM specific rules, procedures, and performance requirements. UTM ConOps 2.0 defines the UTM environment where UAS operations occur at or below 400 feet Above Ground Level (AGL). The ATM environment encompasses all other airspace operations.

Table 1: Operating Environment Perspectives

Environment	Airspace	Basis
UAM	UAM Corridor	UAM ConOps 1.0
UTM	UAS operating at or below 400 ft AGL	UTM ConOps 2.0[2]
ATM	All airspace	Current regulations for all other manned and unmanned aircraft operations including UAM aircraft operating outside of the UAM environment

[2] Federal Aviation Administration. (2020). *Integration of Unmanned Aircraft Systems into the National Airspace System, Concept of Operations v2.0*. Washington, DC: Federal Aviation Administration.

Figure 1-2 illustrates the different environments and types of operations in each environment. UAM Corridors are shown along with aerodromes supporting UAM operations. The following describes the operations inside and outside UAM Corridors for UAM aircraft, fixed wing aircraft, helicopters, and UTM aircraft.

- Inside UAM Corridors:
  - All aircraft operate under UAM specific rules, procedures, and performance requirements
  - Fixed wing aircraft and UTM aircraft cross UAM Corridors
  - Helicopters and UAM aircraft operate within or cross UAM Corridors
  - Operations do not vary with airspace class
- Outside of UAM Corridors, operations adhere to relevant ATM and UTM rules based on operation type, airspace class, and altitude.

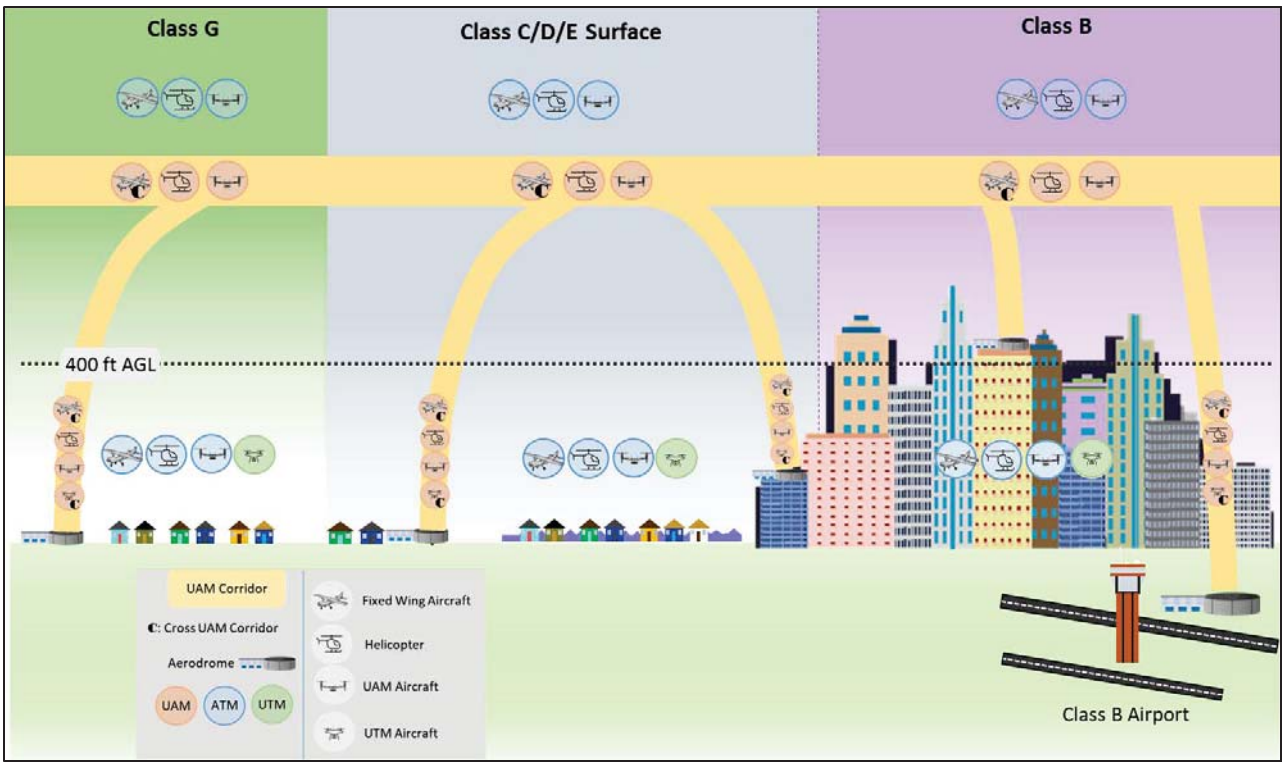

Figure 1-2: UAM, UTM, and ATM Operating Environments

2 Overarching Principles and Assumptions

The following principles and assumptions will be used when guiding the development of the UAM operating environment and evolving the concept:

- UAM will operate within a regulatory, operational, and technical environment that is incorporated within the NAS.
- Any evolution of the regulatory environment will always maintain safety of the NAS.
- The architecture (technology) for UAM services will be flexible and scalable.
- The FAA retains regulatory authority and is responsible for establishing operational parameters and maintaining oversight.
- Operators cannot optimize their own operations at the expense of sub-optimizing the environment as a whole.
- The FAA has on-demand access to information regarding UAM operations.
- Airspace management will be structured where necessary and flexible when possible.
- Cooperative traffic management is conducted in compliance with a set of community developed and FAA-approved Community Based Rules (CBRs).
- The FAA reserves the right to increase individual aircraft operational performance requirements in order to optimize the capacity utilization of the airspace structure.
- Providers of Services for UAM (PSUs) will be utilized by operators to receive/exchange information during UAM operations.
- PSUs will be able to obtain UTM flight information via the UAS Service Supplier (USS) network, and the USS network will be able to obtain UAM flight information via the PSU network.
- UAM operators maintain conformance to shared intent; operators, via PSUs, are aware of intent of other operations in the vicinity.
- FAA Demand Capacity Balancing (DCB) intervention may be required to support operations as the number of UAM operations increases.

3 Evolution of UAM Operations

The evolution of UAM operations is characterized by the following key indicators:

1. **Operational tempo:** representation of the density, frequency, and complexity of UAM operations. Tempo evolves from a small number of low complexity operations to a high density and high rate of complex operations.
2. **UAM structure (airspace and procedural):** the level of complexity of infrastructure and services that support the UAM environment. Structure evolves from current helicopter routing to UAM-specific corridors and associated performance requirements and procedures that reduce operational complexity.
3. **UAM driven regulatory changes:** existing regulations may evolve from current regulations to address the needs for UAM operations' structure and performance.
4. **UAM CBRs:** CBRs augment the UAM-driven regulations to establish the expectations of UAM Operators and PSUs. CBRs are developed by industry based on FAA guidelines and require FAA approval to address elements covered by FAA authority (e.g., NAS safety, DCB, equitable access to airspace, security).
5. **Aircraft automation level:** the level of PIC engagement with the UAM aircraft enabling systems. The following categories describe the evolution of aircraft automation:
    - Human-within-the-Loop (HWTL)
        - Human is always in direct control of the automation (systems)
    - Human-on-the-Loop (HOTL)
        - Human has supervisory control of the automation (systems)
        - Human actively monitors the systems and can take full control when required or desired
    - Human-over-the-Loop (HOVTL)
        - Human is informed, or engaged, by the automation (systems) to take action
        - Human passively monitors the systems and is informed by automation if, and what, action is required
        - Human is engaged by the automation either for exceptions that are not reconcilable or as part of rule set escalation
6. **Location of the PIC:** the physical location of the PIC. UAM operations will evolve from a PIC onboard the UAM aircraft to remote UAM PICs.

The relationship of this UAM ConOps to these key indicators is shown in Figure 3-1 and described in subsections below.

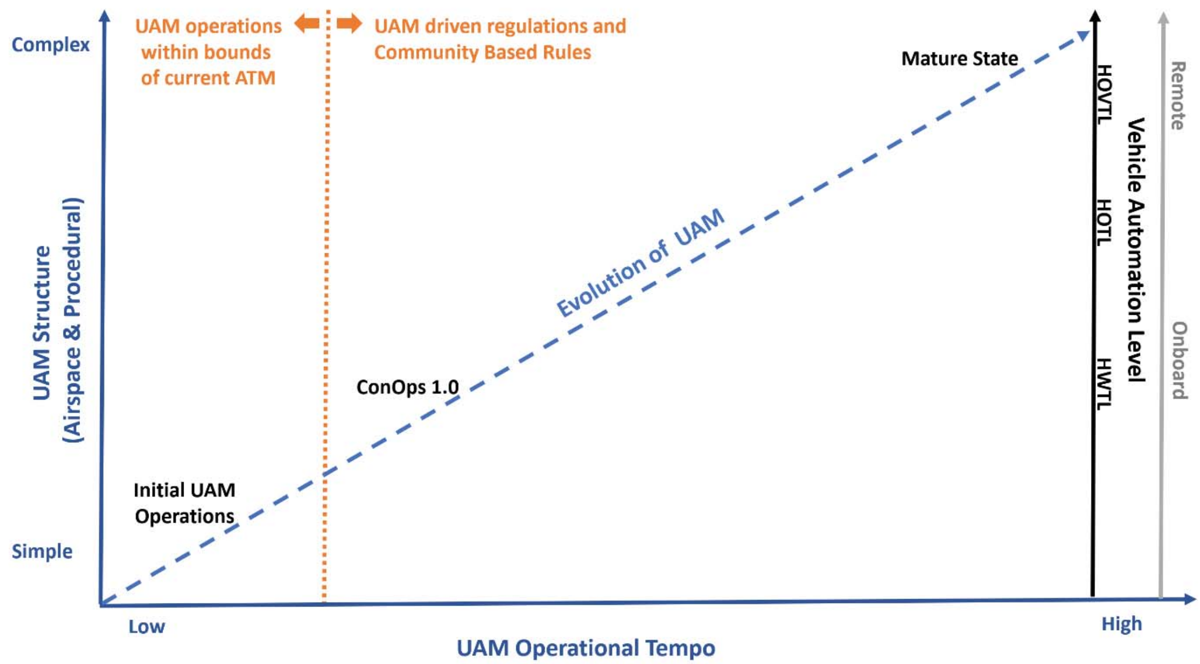

Figure 3-1: Evolution of the UAM Operational Environment

Based on the key indicators, the following UAM operational evolutionary stages are described:

- Initial UAM operations
- ConOps 1.0 operations
- Mature state operations

3.1 Initial UAM Operations

Initial UAM operations are conducted by certified UAM aircraft and conventional helicopters consistent with current rules and regulations. Key indicators of initial UAM operations are:

Operational tempo: Low.

UAM structure (airspace and procedural): Implementation of existing helicopter infrastructure (e.g., routes, helipads, rules and regulations, ATC services). No UAM unique structures or procedures exist.

UAM driven regulatory changes: Initial UAM operations are conducted consistent with the current rules, regulations, and local agreements.

UAM CBRs: No CBRs, only existing agreements such as Letters of Agreement (LOAs).

Aircraft automation level: Consistent with current, manned helicopter technologies.

Location of the PIC: Onboard.

Current helicopter operations (see Appendix D - Helicopter Route Operations) are supported by existing rules, procedures, and routes. As additional operations are initiated, additional procedures, LOAs, routes, and other procedural changes may need to be introduced to accommodate the additional demand and location of operations within the regulatory framework of the current ATM system. Since industry anticipates increasing operations to scale cost effectively and meet increased demand for services, the demand for UAM operations will eventually reach the limits of current regulations and ATC services.

3.2 ConOps 1.0 Operations

With increased operations, UAM operations will need to evolve through changes to the governing regulations augmented by CBRs, UAM structure, and automation. The evolution to a collaborative, information-rich, data-sharing environment will require new technologies and capabilities. UAM operators, the FAA, and other stakeholders will share information with the FAA having on-demand access to identified operational information.

This ConOps represents operations supported by an environment that meets the needs of increased operational tempo. Key indicators of UAM Operations consistent with this ConOps are:

Operational tempo: The operational tempo is low; however, the operational tempo will have increased to a point that requires changes in the existing regulatory framework and procedures.

UAM structure (airspace and procedural): Operations of UAM aircraft occur within defined UAM Corridors from specific aerodromes based on UAM performance requirements. There is minimal UAM Corridor structure or intersections. ATC tactical separation services are not provided for operations within the UAM Corridors. Tactical separation is allocated to the UAM operators, PICs, and PSUs.

UAM driven regulatory changes: Changes to ATM regulations and new UAM regulations that enable operations within UAM Corridors.

UAM CBRs: CBRs are defined by industry to meet industry standards or FAA guidelines when specified. CBRs will require FAA approval.

Aircraft automation level: PICs actively control the aircraft with UAM-specific capabilities.

Location of the PIC: Onboard.

Once the density of these additional operations increases total operations up to the current constraints of the UAM environment, DCB will need to take place effectively managing the demand. To allow these operations to meet operators' business goals, a new approach for UAM flight rules and procedures will be required. UAM-specific structure, new or modified procedures, the regulatory framework, and CBRs will likely be developed to accommodate the increased traffic. The UAM-specific structure – the UAM Corridor – is performance-based airspace structures with defined dimensions. UAM Corridors would be known to airspace users and governed by a set of rules which prescribe access and operations. Where supporting infrastructure and support services meet performance requirements within a UAM Corridor, operators whose aircraft also meet performance requirements will be able to operate within the UAM Corridor.

Initially, the number of UAM Corridors may be small or limited in use, but, over time, additional UAM Corridors may be introduced.

Operations within UAM Corridors will also be supported by CBRs collaboratively developed by the stakeholder community based on industry standards or FAA guidelines and approved by the FAA to ensure that the FAA's regulatory authority is maintained (e.g., NAS safety, DCB for equal access, security). The collaborative development of CBRs allows for stakeholders to agree on norms of interactions foregoing the need for ATC tactical control of individual flights and management of access. The collaboratively developed, transparent, standard CBRs augment the regulatory foundation for UAM operations.

3.3 Mature State Operations

As UAM operational tempo increases, UAM operations will evolve along the lines of the key indicators: structure, regulations, and automation level. Key indicators of mature state UAM operations are:

Operational tempo: The operational tempo increases significantly. Higher operational tempo needs drive the maturity for the other indicators.

UAM structure (airspace and procedural): UAM operations continue to occur within UAM Corridors from aerodromes. The UAM Corridors may form a network to optimize paths between an increasing number of aerodromes; the internal structure of the UAM Corridors may increase in complexity, and the necessary performance parameters for UAM participation may increase.

UAM driven regulatory changes: Additional UAM driven regulations may be necessary to enable operations within UAM Corridors.

UAM CBRs: The complexity of CBRs and involvement in the FAA establishing guidelines or approving CBRs may increase.

Aircraft automation level: Automation improvements may lead to HOVTL capabilities.

Location of the PIC: Remote.

Additional increases in the tempo of ConOps 1.0 operations will require advances to the UAM environment and aircraft. To overcome the constraints, UAM operations will evolve to UAM mature state operations through advances to data sharing, DCB, UAM structure, and aircraft automation. Mature state operations will also include additional CBRs accompanied by UAM-driven regulatory changes.

4 UAM Operational Concept

This section provides an overview of the UAM operational concept (UAM ConOps 1.0) followed by key definitions and descriptions of the roles and responsibilities, UAM Corridors, constraint information and advisories, and operational assumptions.

4.1 Overview

UAM operations transport people or goods from an aerodrome through one or more UAM Corridors to another aerodrome. The UAM Corridor structure, UAM procedures, information sharing, and UAM performance criteria enable increasing operational tempo, without the need for tactical ATC separation services, and minimize impact to ATM and UTM operations. Similar to how UTM is supported by USSs, UAM operations are supported by PSUs that form a PSU network to enhance the capabilities of individual UAM operators in all phases of operations through exchange, analysis, and mediation of information amongst UAM operators, PSUs, USSs, the FAA, and public interest stakeholders (e.g. law enforcement).

Any aircraft operating within a UAM Corridor must meet the performance and participation requirements of the UAM environment. The performance and participation requirements of UAM Corridors may vary for operations wholly within UAM Corridors versus operations crossing UAM Corridors (e.g., general aviation). Within UAM Corridors, strategic deconfliction and tactical separation occur without direct ATC involvement. The UAM community will establish CBRs as standards for operations. The FAA may contribute to CBR guidelines and will approve CBRs to address elements covered by FAA authority (e.g., NAS safety, DCB, equitable access to airspace, security). UAM aircraft operating outside UAM Corridors must follow the operational rules and procedures applicable to the corresponding airspace.

The concept represents an early step in the evolution of the regulatory framework, development of operating rules and performance requirements commensurate with demands of the operation, and a data exchange and information architecture to support UAM operator and FAA responsibilities. UAM leverages a common, shared, technical environment, similar to UTM, where the operators are responsible for coordination, execution, and management of operations and follow CBRs. This networked information exchange is the cornerstone for stakeholders to plan, manage, execute, and oversee UAM operations. Public interest and other stakeholders can access UAM shared operational information.

4.2 Definitions

UAM aerodrome – a location from which UAM flight operations depart or arrive. The use of "UAM aerodrome" and "aerodrome" in this ConOps are synonymous. "UAM aerodrome" is used explicitly when the context indicates functionality to support UAM operations that is not present in current NAS operations.

UAM aircraft – an aircraft that can execute UAM operations.

UAM Corridor – an airspace volume defining a three-dimensional route segment with performance requirements to operate within or cross where tactical ATC separation services are not provided.

UAM operation – the transport of people or goods from one aerodrome to another using UAM Corridors.

UAM Operational Intent ("flight intent") – operation specific information including, but not limited to, UAM operation identification, the intended UAM Corridor(s), aerodromes, and key operational event times (e.g., departure, arrival) of the UAM operation.

UAM operator – the entity responsible for the overall management of a UAM operation; represents the organization that is executing the operation.

UTM operator – operators conducting low altitude UAS operations utilizing UTM-specific services.

4.3 Roles and Responsibilities

This section defines the roles and responsibilities for all actors associated with UAM operations.

4.3.1 FAA

The FAA performs regulatory, ATC, and NAS data exchange roles for UAM.

4.3.1.1 FAA – Regulatory

The FAA is the federal authority over aircraft operations in all airspace and the regulatory and oversight authority for civil operations in the NAS. The FAA maintains an operating environment that ensures airspace users have access to the resources needed to meet specific operational objectives and that shared use of the airspace can be achieved safely and equitably. The FAA develops or modifies regulations to support UAM operations. The FAA may also provide guidelines for CBRs and will approve CBRs to ensure that the FAA authority is maintained (e.g., NAS safety, equal access to airspace, and security). The FAA will define, maintain, and make publicly available UAM Corridor definitions and will manage the performance requirements of UAM Corridors.

4.3.1.2 FAA – Air Traffic Control

The primary purpose of ATC is to prevent collisions involving aircraft operating within the NAS; however, for UAM operations, tactical separation within UAM Corridors is allocated to the UAM community with no tactical ATC services provided by the FAA. ATC may provide advisories regarding UAM operations to other aircraft on a workload permitting basis. As such, ATC must have on-demand access to UAM operational data to ensure safety for aircraft receiving ATC services. ATC may request information as needed from participating actors and may receive automated notifications in accordance with applicable requirements.

The ATC responsibilities that enable UAM operations are:

1. Set UAM Corridor availability (e.g., open or closed) based on operational design (e.g., time of day, flow direction of a nearby airport)

2. Provide advisories regarding UAM operations to other aircraft on a workload permitting basis

3. Respond to UAM off-nominal operations as needed

As part of fulfilling responsibilities, ATC may review any pertinent information from UAM operations.

4.3.1.3 FAA – NAS Data Exchange

FAA NAS data sources are available to UAM operations via FAA-industry exchange protocols. This allows for authorized data flow between the UAM community and FAA operational systems. This interface between the FAA and UAM stakeholders is a gateway such that external entities do not have direct access to FAA systems and data. FAA data sources available via the FAA-industry data exchange include, but are not limited to, flight data, restrictions, charted routes, active Special Activity Airspaces (SAAs).

4.3.2 UAM Operator

UAM operators may conduct operations as scheduled service or on-demand service via a request from an individual customer or from an intermodal operator. UAM operators are responsible for regulatory compliance and all aspects of UAM operation execution. Use of the term ‘Operator’ in this document indicates airspace users electing to conduct operations via cooperative management within the UAM environment.

The UAM operator obtains current conditions from PSU and Supplemental Data Service Provider (SDSP) services (e.g., environment, situational awareness, strategic operational demand, UAM aerodrome availability, supplemental data) to determine the desired UAM Operational Intent information such as location of flight (e.g., aerodrome locations), route (e.g., specific UAM Corridor(s)), and desired flight time.

UAM operators must provide flight intent and operational data to a PSU to operate within or cross UAM Corridors. UAM Operational Intent data serves the following primary functions:

1. Informs other operators of nearby operations within the UAM Corridor to promote safety and shared awareness

2. Enables strategic deconfliction

3. Enables identification and distribution of known airspace constraints and restrictions for the intended area of operation

4. Enables distribution of spatially and temporally relevant advisories, weather, and supplemental data

5. Supports cooperative separation management services (e.g., conformance monitoring, advisory services)

The UAM operator also plans for off-nominal events. This includes an understanding of alternative landing sites and the airspace classes that border the UAM Corridor(s) for the operation.

Upon completion of the operation, the UAM operator notifies the PSU.

4.3.3 Pilot in Command (PIC)

The PIC is the person aboard the UAM aircraft who is ultimately responsible for the operation and safety during flight.

4.3.4 Provider of Services for UAM (PSU)

A PSU is an entity that supports UAM operators with meeting UAM operational requirements that enable safe, efficient, and secure use of the airspace. A PSU:

1. Provides a communication bridge between federated UAM actors, PSU to PSU via the PSU Network, to support the UAM operator's ability to meet the regulatory and operational requirements for UAM operations

2. Provides the UAM operator with information gathered from the PSU Network, about planned UAM operations in a UAM Corridor so that UAM operators can ascertain the ability to conduct safe and efficient missions

3. Analyzes and confirms that a UAM operator's Operational Intent is complete, consistent with current advisories and restrictions, and strategically deconflicted considering already established flight intent of other UAM operators, the CBRs, UAM Corridor capacity, airspace restrictions, UAM aerodrome resource availability, and adverse environmental conditions

4. Provides the confirmed flight intent to the PSU network

5. Distributes notifications (e.g., constraints, restrictions) for the intended area of operation

6. Distributes FAA operational data and advisories, weather, and supplemental data

7. Supports cooperative separation management services (e.g., conformance monitoring, advisory services)

8. Determines UAM Corridor use status

    a. UAM Corridor use status (e.g., active, inactive) is an indication that one or more UAM operations are occurring in the UAM Corridor

9. Archives operational data in historical databases for analytics, regulatory, and UAM operator accountability purposes

These key functions allow a PSU to provide cooperative management for UAM operations without direct FAA involvement on a per flight basis.

PSU services support operations planning, flight intent sharing, strategic and tactical deconfliction, airspace management functions, and support to off-nominal operations. PSUs may provide value-added services to subscribers that optimize operations or provide access to supplemental data in support of UAM operations. PSUs exchange information with other PSUs via the PSU Network to enable UAM services (e.g., exchange of flight intent information, notification of UAM Corridor status, information queries). PSUs also support local municipalities and communities, as needed, to gather, incorporate, and maintain airspace reservations that may be accessed by UAM operators.

4.3.5 PSU Network

A PSU Network is the collection of connected PSUs that share subscriber information, FAA data, SDSP data, and USS data with other entities (e.g., PSUs, FAA, USSs, public interest stakeholders) to provide a common operational picture to support UAM operations. Since multiple PSUs can provide services in the same geographical area, the PSU Network facilitates the ready availability of data to the FAA and other entities as required to ensure safe operation of the NAS and any other information sharing functions including security and identification.

4.3.6 Supplemental Data Service Providers

UAM operators and PSUs use Supplemental Data Service Providers (SDSPs) to access supporting data including, but not limited to, terrain, obstacle, aerodrome availability, and specialized weather. SDSPs may be accessed via the PSU network or directly by UAM operators.

4.3.7 UAM Aerodrome

A UAM aerodrome is an aerodrome that meets the capability requirements to support UAM departure and arrival operations. The UAM aerodrome provides current and future resource availability information for UAM operations (e.g., open/closed, pad availability) to support UAM operator planning and PSU strategic deconfliction. UAM aerodrome availability is accessible via the PSU network or directly by UAM operators via an SDSP. The UAM aerodrome information is used by UAM operators and PSUs for UAM operation planning including strategic deconfliction and DCB; however, the UAM aerodromes do not provide strategic deconfliction or DCB services.

4.3.8 UAS Service Supplier

USSs are entities that support UAS operations under the UAS Traffic Management (UTM) system. See UTM Concept of Operations 2.0 for more details.

From a UAM operational perspective, USSs will interact with PSUs as follows:

1. Enable UTM operations to use PSU network services to cross a UAM Corridor
2. Support UAM off-nominal operations as needed
3. Support UTM off-nominal operations as needed

4.3.9 Other NAS Airspace Users

Other NAS Airspace Users are any non-UAM aircraft operation within the NAS. Other NAS Airspace Users have the responsibility to know about and meet the relevant performance and participation requirements to operate in, or cross, active UAM Corridors or avoid the active UAM Corridors. UAM Corridor definitions and availability will be publicly available.

4.3.10 Public Interest Stakeholders

Public interest stakeholders are entities declared by governing processes (e.g., FAA, CBR) to be able to access UAM operational information. This access may support activities including, but not limited to, public right to know, government regulatory, government assured safety and security, and public safety. Examples of public interest stakeholders are local law enforcement and US federal agencies.

4.4 UAM Corridors

UAM Corridors enable safe and efficient UAM operations without tactical ATC separation services. The UAM Corridors support increasing operational tempo that are related to UAM operator capability (e.g., aircraft performance), UAM Corridor structure, and UAM procedures. UAM Corridors are the primary mechanism of separation between UAM operations and ATM and UTM operations that do not meet UAM performance and participation requirements.

An operational view of UAM Corridors was shown in Figure 3-1.

Operations within UAM Corridors will have operational performance (e.g., aircraft performance envelope, navigation, DAA) and participation (e.g., flight intent sharing, deconfliction within the UAM Corridor) requirements. The performance and participation requirements of UAM Corridors may vary between UAM Corridors. Additionally, the requirements may vary for operations wholly within UAM Corridors and operations crossing UAM Corridors (e.g., general aviation). UAM Corridor performance and participation requirements support adjustments for most UAM off-nominal operations where the UAM aircraft can complete the operation safely. Any operator that meets the UAM Corridor performance and participation requirements may operate in, or cross, the UAM Corridor.

UAM Corridor definitions are available to stakeholders for planning and operational use. ATC will be aware of UAM Corridors as part of general awareness of the airspace for which ATC is responsible. Other NAS Users will be aware of UAM Corridors through airspace familiarization associated with flight planning or ATC flight plan approval or advisories. UAM Corridor design considerations include:

1. Minimal impact to existing ATM and UTM operations
2. Public interest stakeholder needs (e.g., local environmental and noise, safety, security)
3. Stakeholder utility (e.g., customer need)

UAM Corridor availability (e.g., open, closed) is in accordance with ATC operational design (e.g., nearby airport flow direction change). UAM Corridor availability is communicated through the PSU network to PSUs and UAM operators. In addition to UAM Corridor availability established by ATC, PSUs determine UAM Corridor status that identifies if one or more UAM operations are occurring somewhere within the UAM Corridor. UAM Corridor usage information may be used by the FAA or other stakeholders for situational awareness.

Initially, the UAM Corridors connect two known aerodrome locations to support point-to-point UAM operations. As UAM operations evolve, UAM Corridors may be segmented and connected to form more complex and efficient networks of available routing between aerodromes. Figure 4-1 shows a small number of point-to-point UAM Corridors.

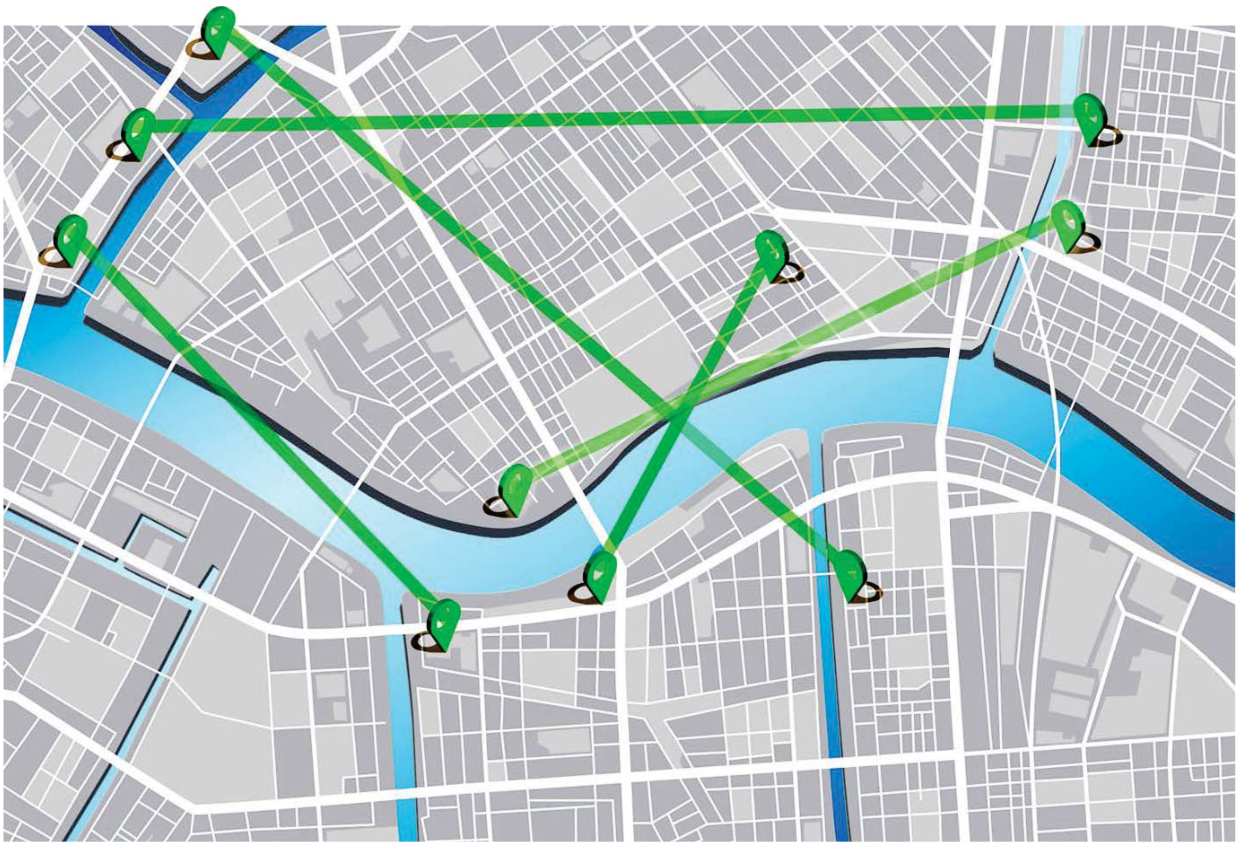

Figure 4-1: Multiple UAM Corridors

4.4.1 UAM Corridor Demand Capacity Balancing

DCB applies when the UAM Corridor or aerodromes cannot support the collective UAM Operational Intent demand. DCB business rules are part of FAA-approved CBRs. In certain circumstances, the excessive demand may not be due to UAM Corridor capacity but due to other factors such as congestion at the aerodrome. The application of DCB will be consistent with FAA authority including access, equity, safety, and security.

4.4.2 UAM Corridor Evolution

Increasing UAM operational tempo may create demand in excess of a corridor's current capacity at which point additional capacity may be made available through additional structure (e.g., "tracks"), increased performance levels (e.g., ability to safely reduce separation minima within the corridor through various methods), or expanded UAM Corridor topology.

Figure 4-2 depicts a notional internal structure of "tracks" that may meet a future UAM operational requirement. The "tracks" represent additional internal structure with increased performance requirements that support an increased operational tempo within the same UAM Corridor.

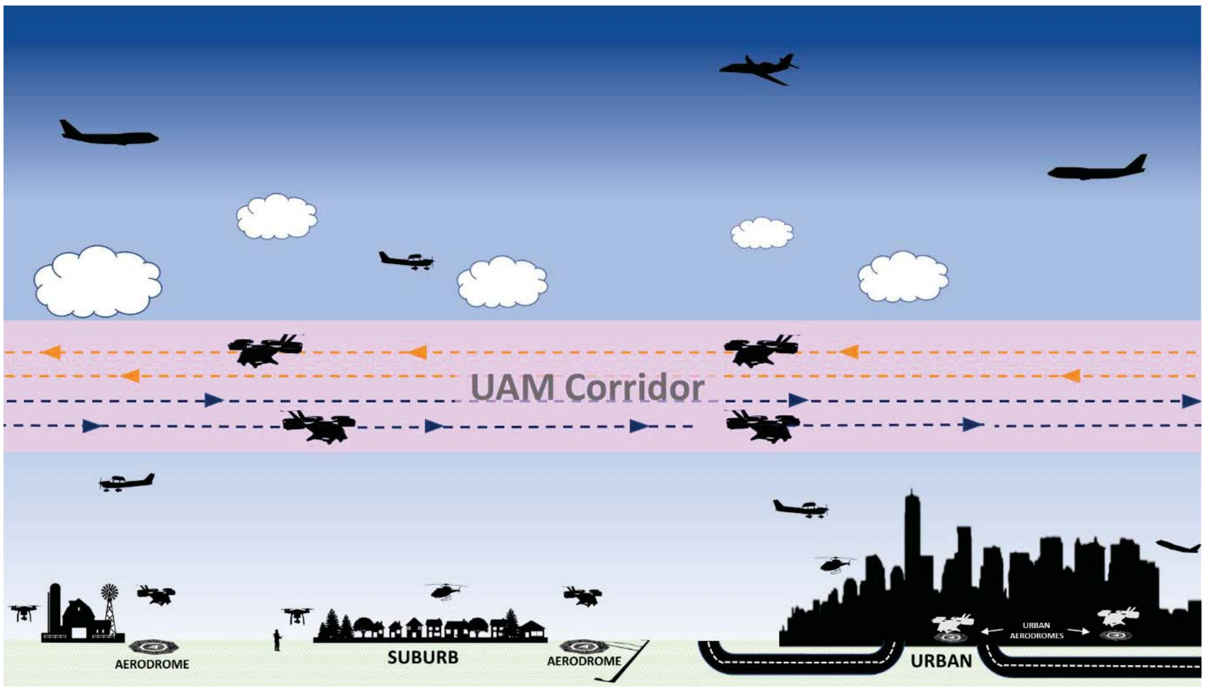

Figure 4-2: UAM Corridor with "Tracks"

4.5 UAM Separation

Separation of operations within UAM Corridors is assured through various strategic and tactical methods. The primary method is strategic deconfliction based on collaborative flight intent sharing. Tactical separation is allocated to the UAM operators, including PIC and aircraft capabilities, and may include support from the PSUs.

When operating within a UAM Corridor, the FAA regulations and CBRs include the manner of strategic deconfliction and tactical separation. The strategic deconfliction rules are exercised by the PSUs. UAM operators remain responsible for the safe conduct of operations including operating relative to other aircraft, weather, terrain, and hazards and avoiding unsafe conditions. UAM separation is achieved via shared flight intent, shared awareness, strategic deconfliction of flight intent, and the establishment of procedural rules.

In addition to strategic deconfliction within UAM Corridors that occurs during UAM flight planning, responsibilities also exist for in-flight coordination to ensure tactical separation is maintained. The PIC, supported by the UAM aircraft's capabilities (e.g., DAA) and possibly PSU services (e.g., flight data from active operations in the UAM Corridor), maintains separation from other operations within the UAM Corridor. In the event a tactical action results in a UAM aircraft operating outside of the bounds of shared UAM Operational Intent, notifications of the off-nominal event and updates to the UAM Operational Intent, if applicable, are shared via the PSU Network.

The regulatory framework governing UAM operations will evolve to account for increasing levels of performance and automation which may include autonomous flight. This evolution may have implications for approaches to separation between aircraft in airspace that includes UAM operations.

4.6 Weather and Obstacles Within UAM Corridors

PSUs or SDSPs support the UAM operator by supplying weather, terrain, and obstacle clearance data specific to the UAM operation. This data is obtained in the flight planning phase to ensure strategic management of a UAM operation and updated in-flight, as appropriate. UAM operators monitor weather and winds prior to and throughout flight. In the event that aircraft performance is inadequate to maintain required separation within the UAM Corridor due to forecasted or current weather, UAM operators are responsible to take appropriate strategic and tactical action to ensure separation is maintained (e.g., do not take off, exit the UAM Corridor and operate per appropriate airspace rules).

4.7 Constraint Information and Advisories

UAM operators are responsible for identifying operational conditions or flight hazards that may affect an operation. This information is collected and assessed both prior to and during flight in order to ensure the safe conduct of the flight. PSUs support this UAM operator responsibility by supplying information and advisories including, but not limited to:

- Other airborne traffic including operations within and crossing UAM Corridors
- Weather and winds
- Other hazards pertinent to low altitude flight (e.g., obstacles such as a crane or power-line Notices to Airmen (NOTAM), bird activity, local restrictions)
- Special Activity Airspace status
- UAM Corridor availability

4.8 UAM Operational Assumptions

The following assumptions apply to UAM Operations:

- UAM aircraft identification and location information are available to the UAM operator and to the PSU Network. This is not provided by ADS-B Out or transponders for operations in the UAM Corridor(s); however, other functionality (e.g., UAM applicable Remote ID) may support this identification and location information capability.

- Two-way voice communication with ATC will not be conducted inside UAM Corridors during nominal operations.
- The UAM operator will not receive ATC clearances nor ATC authorizations for operations in UAM Corridors.
- Operational ATC involvement is limited to setting UAM Corridor availability based on the ATC operational design, receiving UAM Corridor status for awareness of which UAM Corridors have active operations, and responding to UAM off-nominal events as needed.

5 Notional Architecture

Within the UAM cooperative management environment, the FAA maintains regulatory and operational authority for airspace and traffic operations. UAM operations are organized, coordinated, and managed by a federated set of actors through a distributed network that leverages interoperable information systems. Figure 5-1 depicts a notional architecture of the UAM actors and contextual relationships and information flows. This architecture is based on patterns established within the UTM architecture described in the FAA's UTM Concept of Operations.

The PSU network, comprised of individual PSUs operating as a collective, lies at the center of the UAM notional architecture and exchanges data with UAM operators, USSs, SDSPs, the FAA, and public interest stakeholders. PSUs receive supplemental data supporting UAM operation management from the SDSPs and provide relevant UAM operational data to the public. PSUs communicate and coordinate via the PSU network. This allows other UAM stakeholders (e.g. a UAM operator, ATC, law enforcement) connected to a PSU to access data shared by the PSU network.

PSUs and USSs exchange operational information about UAM and UTM operations. Notionally, a USS can expand to become a PSU, and vice versa, based on services provided. Combined service providers will support operations in both the UAM and UTM environments. The architecture depicts the connectivity of the PSU network to USSs for information exchange while retaining a UAM-centric architectural view.

The vertical dot-dashed line in Figure 5-1 represents the demarcation between the FAA and industry responsibilities for the infrastructure, services, and entities that interact as part of UAM. The FAA-Industry Data Exchange Protocol provides an interface for the NAS Data Exchange to request UAM operational data on demand and send FAA information to the PSU network for distribution to UAM operators, PICs, UAM Aircraft, and public interest stakeholders.

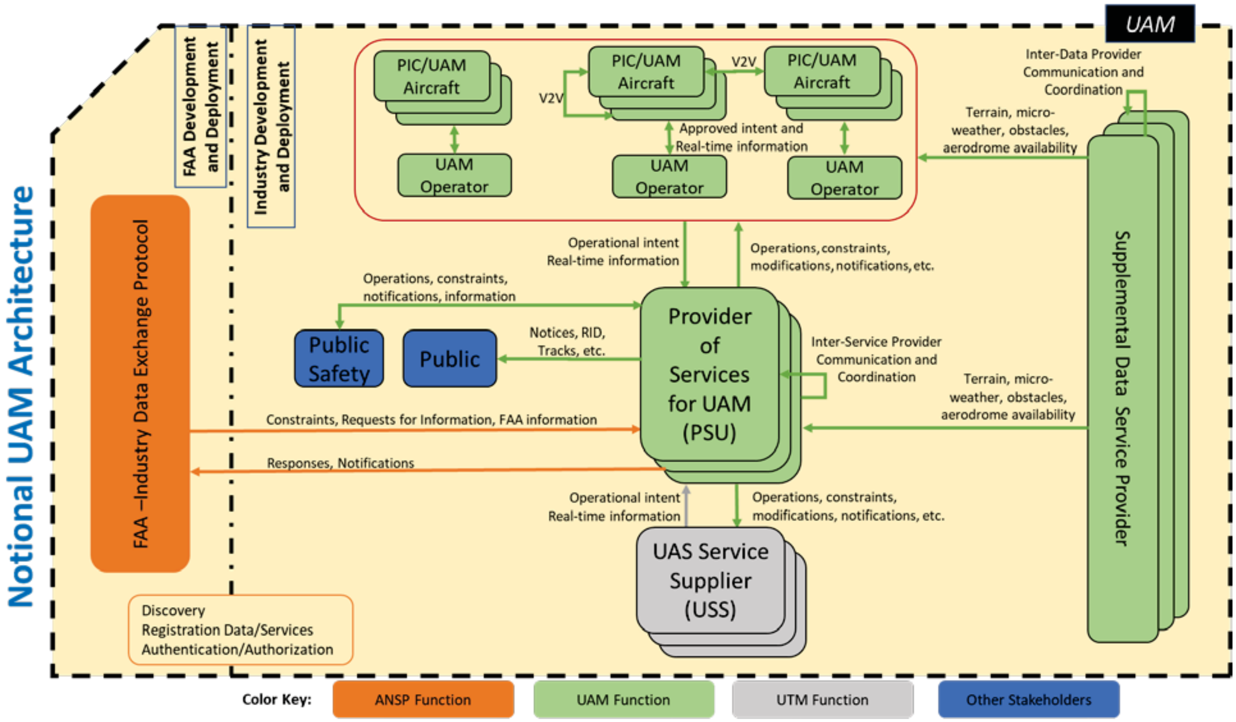

Figure 5-1: Notional UAM Architecture

5.1 Supporting Services

UAM services provided by PSUs and SDSPs are modular and discrete allowing for increased flexibility in the design and implementation of new services. This modular approach allows the FAA to provide tailored oversight of UAM operations and allows PSUs and SDSPs to provide focused services consistent with a business model and subscriber needs.

Similar to UTM, UAM services can be characterized in one of the following ways:

1. Services that are required to be used by UAM operators due to FAA regulation or for a direct connection to FAA systems. These services must be qualified and approved by the FAA.

2. Services that may be used by a UAM operator to meet all or part of an FAA regulation. These services must meet an acceptable means of compliance and may be individually qualified and approved by the FAA.

3. Services that provide value-added assistance to a UAM operator but are not used for FAA regulatory compliance. These services may meet an industry standard but will not be qualified or approved by the FAA.

6 UAM Use Cases and Scenarios

This section introduces several high-level use cases and scenarios to further explore the UAM concept. The use cases develop scenarios that step through the relevant portions of a specific operation. The use cases illustrate the operational and architectural information from Sections 4 and 5.

The use cases (see Table 2) illustrate a subset of UAM operations and interactions during specific nominal and off-nominal operations. A nominal UAM operation is a single UAM operation that executes in accordance with the established performances, rules, policies, and procedures. An off-nominal operation deviates from nominal operations.

Table 2: Use Case Descriptions

Use Case Title	Description
Nominal UAM Use Case	• Explores a UAM operation at a high-level including operations within a UAM Corridor, strategic deconfliction, information exchanges between operators, and information needs
Off-Nominal UAM Use Case	• Explores conformance monitoring and situations in which operations are non-conforming with shared, planned flight intent • Explores contingency situations

6.1 Nominal UAM Use Case

6.1.1 Nominal UAM Operations Through a Single UAM Corridor

This use case covers a single UAM operation of on-demand service between two aerodromes. This use case description is a specific operation that conforms to the UAM Operational concept described in Section 4.8 and is independent of airspace class. UAM operations occur in the following phases: Planning, Departure, En Route, Arrival, and Post Operations. Throughout all phases of operation, the UAM operator's actions may be supported by service providers.

6.1.1.1 Planning Phase

Planning of this operation starts with the UAM operator receiving a request from an individual customer for a flight between Aerodrome A and Aerodrome B.

The UAM operator obtains current conditions from their subscribed PSU as well as relevant SDSP services (e.g., environment, situational awareness, strategic operational demand, UAM aerodrome availability, supplemental data).

After determining that the current conditions are acceptable for the operation, the UAM operator submits desired UAM Operational Intent information (e.g., identifying information, aerodrome locations, route of flight via UAM Corridor(s), desired time of operation) to the subscribed PSU.

The PSU, through the PSU network:

1. Evaluates the desired UAM Operational Intent for other operations that may cause a strategic conflict

2. Evaluates UAM Operational Intent against known airspace constraints (e.g., FAA originating constraints, local restrictions)

3. Identifies availability of UAM Corridors and UAM aerodrome resources

4. Identifies adverse operating environment conditions

Because there are no conflicting operations, airspace restrictions (e.g., TFR), or aerodrome resource limitations, the UAM operator's desired UAM Operational Intent is considered strategically deconflicted and confirmed. The PSU notifies the UAM operator and provides the UAM Operational Intent to the PSU network.

The UAM operator considers possible actions due to an off-nominal event. Alternate landing locations are evaluated. The airspace classes and ATC facilities with jurisdiction for the airspaces that border the UAM Corridor(s) for the operation are identified. These prepare the PIC in the event that a contingency operation is required.

The majority of the planning actions and information exchanges between the UAM operator and PSU are automated and are expected to take very little time from the initial customer request to the confirmed UAM Operational Intent.

6.1.1.2 In-Flight Phases

Throughout all phases of flight (e.g., Departure, En Route, Arrival), the UAM aircraft identification and location information are available to the UAM operator and subscribed PSU. The PIC and UAM operator monitor aircraft performance to identify an off-nominal state. The PSU monitors operational conformance to the confirmed UAM Operational Intent.

6.1.1.2.1 Departure Phase

The PIC departs from Aerodrome A within the departure compliance window and enters the UAM Corridor.

6.1.1.2.2 En Route Phase

The PIC navigates along the UAM Corridor per the confirmed UAM Operational Intent. The PIC maintains tactical separation from other aircraft within the UAM corridor with possible support from the UAM aircraft (e.g., DAA) or PSU services (e.g., flight data from active operations in the UAM Corridor). Tactical separation responsibilities for encounters in a UAM Corridor are shared by the UAM PIC and other NAS Airspace Users. The UAM aircraft completes the en route portion of the flight per the UAM Operational Intent and approaches the arrival aerodrome within the compliance window of the arrival time.

6.1.1.2.3 Arrival Phase

As the UAM aircraft approaches the arrival aerodrome, the PIC, UAM operator, PSU, and UAM aerodrome confirm the landing pad is still available per the UAM Operational Intent. The PIC navigates to the allocated aerodrome pad and lands the aircraft.

6.1.1.3 Post Operations Phase

The UAM operator provides mission completion indication to the PSU. The PSU archives required UAM operational data.

6.2 Off-Nominal UAM Use Case

Two specific off-nominal use case scenarios are presented in this section; each describes a different off-nominal situation that may occur during a UAM operation.

6.2.1 UAM Operation Non-Conformant to Shared UAM Operational Intent

This scenario explores a situation where a UAM operation is not in conformance with the confirmed UAM Operational Intent due to performance issues, high winds, and navigation degradation. In this scenario, the UAM aircraft can safely continue within the UAM Corridor to the originally planned aerodrome. Prior to the determination of the off-nominal event, the UAM operation is consistent with the phases and steps defined in the Nominal Use Case (see Section 6.1).

During the en route phase, the UAM operation enters a situation of non-conformance with the confirmed UAM Operational Intent which may be detected by the PIC, the UAM operator, or the PSU. The UAM operator's PSU notifies impacted subscribers and distributes information about the off-nominal event through the PSU network for other PSUs to notify other affected UAM operations. The UAM operator and PSU are able to confirm a new UAM Operational Intent that meets the CBRs and UAM Corridor performance requirements to resolve the off-nominal situation and allow the operation to continue to the aerodrome in the UAM Corridor. If a new UAM Operational Intent could not be confirmed, the UAM aircraft would have exited the UAM Corridor and continued the operation consistent with requirements of the airspace class entered. The UAM operator continues to maintain separation (e.g., DAA capabilities, right-of-way rules) to complete the operation. The PSU continues to distribute operational data associated with the flight through the PSU Network.

The arrival phase is consistent with the steps outlined in Nominal Use Case since the off-nominal event remained in the UAM Corridor and did not result in a conflict at the arrival aerodrome.

During the post operations phase, the UAM operator provides mission completion indication to the PSU, the PSU archives required UAM operational data, and the UAM operator submits information to the reporting process for the off-nominal event, as required.

6.2.2 UAM Operational Contingency

This scenario explores a situation where a UAM aircraft is non-conformant to the UAM Operational Intent due to a failure that results in a forced landing. In this scenario, the UAM aircraft is expected to exit the UAM Corridor. As a result, the description of this scenario is dependent on airspace classification since ATC services may be impacted.

Prior to the determination of the off-nominal event, the UAM operation is consistent with the phases and steps defined in Nominal Use Case (see Section 6.1). During the en route phase, the UAM aircraft experiences an in-flight contingency situation, identified by the PIC, and is expected to exit the UAM Corridor. As with manned operations in the NAS during an contingency, the PIC's order of responsibility is to: 1) Aviate (fly the aircraft), 2) Navigate (maintain an intended course), and 3) Communicate (notify ATC of the contingency). For this scenario, the PIC must focus entirely on flying the aircraft for a safe landing. The UAM operator detects the contingency and notifies the PSU for distribution of relevant information through the PSU network. Prior to the UAM aircraft exiting the UAM Corridor into Class B airspace, the PIC turns on ADS-B out and the transponder as a mean of ATC identification and contacts ATC. Once contacted, ATC determines the possible impact of the contingency UAM operation on other aircraft receiving ATC services and provides advisories or ATC instructions as necessary to mitigate the risk to other aircraft.

The PIC identifies a safe and suitable landing location. The landing location is not an aerodrome.

During the post operations phase, the UAM operator provides mission completion indication to the PSU, the PSU archives required UAM operational data, and the UAM operator submits information to the reporting process for the off-nominal event, as required. ATC also submits information to the reporting process, as required.

7 UAM Implementation

UAM ConOps 1.0 implementation is the set of FAA efforts, in collaboration with NASA, industry, and other stakeholders, that transform UAM operations from current, helicopter operations to the operations described in Section 4. UAM implementation also sets the stage for further transformation to the mature state operations depicted in Section 3.3. The implementation will safely, efficiently, and securely incorporate the entrance of the UAM aircraft and operations while ensuring the integrity of current NAS operations.

UAM implementation is an evolutionary developmental approach starting with low-complexity, low-operational tempo operations and building toward an environment of higher operational tempo and the introduction of UAM airspace structure to mitigate an otherwise higher level of complexity. The concept will evolve through the results of analysis, simulation, demonstration, and community engagement. While the concept evolves, the FAA will engage stakeholders to set high level principles and assumptions on performance with an understanding that the principles and assumptions will be implemented as required. Stakeholders will develop and adopt applicable CBRs related to collaboration, information sharing, operational protocols, and equipment performance to support the automated nature of the envisioned cooperative environment. This concept will mature to encompass increasingly complex operations in heavily populated environments and more heavily utilized airspace.

This evolutionary approach to UAM implementation provides several advantages. By initially addressing lower complexity operations, where technological requirements and services should be the least stringent, implementation can be streamlined to the environment using current capabilities that meet performance requirements and do not require a full-scale regulatory and operational infrastructure. UAM operations will adapt to new technologies and automation, both ground-based and airborne, and increasingly allow for more advanced forms of interaction with the ATM environment through collaborative systems capable of automated information exchange. UAM operations will also support the range of UAM demand, business models, applications, and technologies, support safe, efficient, and secure operations that coexist with other operations (e.g., manned aircraft, UTM), impose minimal disruption to the existing ATM system, and maintain fair and equitable access to airspace.

Appendix A - References

Federal Aviation Administration. (2020). *Integration of Unmanned Aircraft Systems into the National Airspace System, Concept of Operations v2.0*. Washington, DC: Federal Aviation Administration

Texas A&M Transportation Institute. (2019). *2019 Urban Mobility Report*. https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2019.pdf

Appendix B - Acronyms

Acronym	Definition
AAM	Advanced Air Mobility
ADS-B	Automatic Dependent Surveillance - Broadcast
AGL	Above Ground Level
ANG	FAA Organization – NextGen Program Office
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATM	Air Traffic Management
CBR	Community Business Rule
ConOps	Concept of Operations
DAA	Detect and Avoid
DCB	Demand Capacity Balancing
DEP	Distributed Electric Propulsion
eVTOL	Electric Vertical Take-Off and Landing
FAA	Federal Aviation Administration
HOTL	Human-on-the-Loop
HOVTL	Human-over-the-Loop
HWTL	Human-within-the-Loop
LOA	Letter of Agreement
NAS	National Airspace System

Acronym	Definition
NASA	National Aeronautics and Space Administration
NOTAM	Notice to Airmen
PIC	Pilot in Command
PSU	Provider of Services for UAM
RID	Remote Identification (ID)
SAA	Special Activity Airspace
SDSP	Supplemental Data Service Provider
SWIM	System Wide Information Management
TFR	Temporary Flight Restriction
UAM	Urban Air Mobility
UAS	Unmanned Aircraft System
USS	UAS Service Supplier
UTM	UAS Traffic Management
V2V	Vehicle-to-Vehicle
VTOL	Vertical Take-Off and Landing

Appendix C - Glossary

Term	Definition
Air Traffic Management (ATM)	The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management — safely, economically and efficiently — through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions. (Source: ICAO Doc 4444 PANS-ATM)
Community Business Rules (CBR)	Collaborative set of UAM operational business rules developed by the stakeholder community. Rules may be set by the UAM community to meet industry standards or FAA guidelines when specified. CBRs will require FAA approval.
Conflict	A point in time in which the predicted separation of two or more aircraft is less than the defined separation minima.
Constraint	An impact to the capacity of a resource. Constraints can be natural (e.g., weather), circumstantial (e.g., runway construction), or intentional (e.g., TFR).
Cooperative Separation	Separation based on shared flight intent and data exchanges between operators, stakeholders, and service providers and supported by the appropriate rules, regulations, and policies for the planned operations. Air Navigation Service Providers (ANSP) do not provide tactical ATC separation services for UAM operations.
Demand Capacity Balancing (DCB)	Flight intent adjustments during the planning phase to ensure that predicted demand does not exceed the capacity of a resource (e.g., UAM Corridor, aerodrome).
Human-on-the-Loop (HOTL)	Human supervisory control of the automation (systems) where the human actively monitors the systems and can take full control when required or desired
Human-over-the-Loop (HOVTL)	Human informed, or engaged, by the automation (system) to take actions. Human passively monitors the systems and is informed by automation if, and what, action is required. Human is engaged by the automation either for exceptions that are not reconcilable or as part of rule set escalation.

Term	Definition
Human-within-the-Loop (HWTL)	Human is always in direct control of the automation (systems).
Operational Tempo	The density, frequency, and complexity of operations.
Providers of Services for UAM (PSU)	An entity that assists UAM operators with meeting UAM operational requirements to enable safe and efficient use of UAM Corridors and aerodromes. This service provider shares operational data with stakeholders and confirms flight intent.
PSU Network	A collection of PSUs with access to each PSU's data for use and sharing with their subscribers.
Strategic Deconfliction	Deconfliction of UAM Operational Intent via advanced planning and information exchange.
Tactical Separation	UAM operator responsibility for tactical conflict and collision avoidance.
UAM aerodrome	A location from which UAM flights arrive and depart.
UAM aircraft	An aircraft that can execute UAM operations.
UAM Corridor	An airspace volume defining a three-dimensional route segment with performance requirements to operate within or cross where tactical ATC separation services are not provided.
UAM operation	The transport of people or goods from one aerodrome to another using UAM Corridors.
UAM Operational Intent	Operation specific information including, but not limited to, UAM operation identification, the intended UAM Corridor(s), aerodromes, and key operational event times (e.g., departure, arrival) of the UAM operation.
UAM operator	The person or entity responsible for the overall management of an UAM operation; represents the organization that is executing the operation.
UAS Traffic Management (UTM)	The manner in which the FAA will support operations for UAS operating in low altitude airspace.

Term	Definition
UTM operator	Operators conducting low altitude UAS operations utilizing UTM-specific services.

Appendix D - Helicopter Route Operations

Current Helicopter Route operations are helicopters using locally, charted airspace structures, Helicopter Routes, to simplify the interactions between a helicopter PIC and ATC. Helicopter Route operations have the similar high-level operational patterns and concerns as initial UAM operations. This appendix is a brief description of nominal operations that occur today and offers a point of comparison to the operations described in Sections 4 and 6.1. The comparison is summarized in Table D-1.

Table D-1: Comparison of Helicopter Route Operations and UAM Operations

Operational Attribute	Helicopter Route Operations	ConOps 1.0 UAM Operations	Similar or Different
Use of airspace structure	Intended for helicopter operations per airspace class regulations	Intended for UAM operations that meet UAM Corridor performance and participation requirements	Similar
Tactical ATC Separation within airspace structure	No	No	Similar
ATC separates other traffic from the airspace structure	Yes, airspace class specific	Yes, airspace class specific	Similar
2-way communications with ATC	Yes, airspace class specific	No, for nominal operations in UAM Corridors	Similar
Monitor ATC frequency	Yes, airspace class specific	Not required	Different
Operations that may occur within structure	Any operation subject to airspace class regulations	Any operations that can meet UAM Corridor performance and participation requirements	Different
Airspace permissions	Yes - approval by ATC into the airspaces consistent with airspace class rules - use of Helicopter Routes simplifies the ATC approval considerations	Yes - through negotiated UAM Operational Intent (not ATC approved)	Different
Use of ADS-B Out and Transponders during operations	Yes, airspace class specific	Not during nominal operations within UAM Corridors	Different
ATC monitors flight progress within airspace structure	Yes	No	Different

Operational Attribute	Helicopter Route Operations	ConOps 1.0 UAM Operations	Similar or Different
Variations based on airspace class	Yes, airspace class rules apply for equipage and interactions with, and approval by, ATC	No	Different

Nominal Helicopter Route operations can be organized by the following groupings:

1. Operation Independent: activities that occur continuously in the "background" of any individual helicopter operation

2. Operation Dependent: activities that occur within the context of the execution of a specific Helicopter Route operation

The following special procedures apply to helicopters operating in Helicopter Routes:

1. Modified regulations (e.g., through Letters of Agreement (LOAs)) streamline two-way voice communication with ATC

2. ATC involvement includes setting Helicopter Route availability, providing ATC clearances for Helicopter Routes that traverse Class B airspace, and providing advisories as appropriate when workload permits

Operation Independent Activities

Operation independent activities include actions by the FAA, ATC, and heliports.

The FAA takes the following actions:

1. Local facility defines and makes publicly available Helicopter Routes

2. Makes available NAS Operational Data to the PIC including maintaining existing FAA information distribution systems (e.g., SWIM, NOTAMs, TFRs) and supporting processes

ATC determines the availability of Helicopter Routes. Availability is an indication that helicopters may use the route.

Heliports maintain heliport availability and pad utilization schedule. This supports the planning activity consider helipad availability based on operating hours and utilization.

Operation Dependent Activities

Within the context of Operation Dependent activities, Helicopter Route operations occur in the following phases: Planning, Departure, En Route, Arrival, and Post Operations.

Planning Phase

As helicopter operations may be on-demand services, initiation of this operation starts with the PIC receiving a request from an individual customer for a flight between helipad A in Class G airspace and helipad B in Class B airspace. The planned trajectory includes the option to use a Helicopter Route that begins in Class G airspace and proceeds through a portion of Class B airspace to the vicinity of helipad B. No other airspace classes are traversed in this operation.

The PIC obtains current conditions from Automatic Terminal Information Service (ATIS) or ATC. The PIC determines desired flight intent including origination and destination heliports, airspace classes to transit (and associated requirements), and specific Helicopter Route(s) based on availability.

The PIC completes the following:

1. Plans for off-nominal events and alternative landing locations
2. Identifies the rules, regulations, and procedures associated with each class of airspace traversed during the operation
3. Obtains all relevant information (e.g., NOTAMs, TFRs, ATIS) from FAA information distribution systems

Departure Phase

The PIC takes-off from helipad A in Class G airspace.

En Route Phase

The PIC navigates towards Class B airspace noting the proposed use of the Helicopter Route. The PIC requests an ATC Clearance to enter Class B airspace from the appropriate ATC facility on the appropriate frequency. ATC reviews the airspace, notes the intended operations along the intended flight path in Class B, grants the ATC Clearance as requested, issues additional instructions to notify ATC when landing assured, and begins monitoring the progress of the flight. The PIC enters the Helicopter Route, navigates along the route, and enters Class B airspace.

As the PIC navigates along the Helicopter Route in Class B:

1. ATC separates, when possible, other NAS Users from the Helicopter Route but not the individual helicopter.
2. The PIC shares with other helicopters the responsibility for separation (e.g., see and avoid) from other helicopters within the Helicopter Route.
3. The PIC does not contact ATC for situations that would normally warrant communication in Class B (e.g., course changes) as long as the helicopter remains on the cleared Helicopter Route.
4. The PIC continues to helipad B.

Arrival Phase

As the helicopter approaches the arrival helipad located at the Class B airport, the PIC confirms the landing pad is still available per the flight intent. The PIC contacts ATC on the appropriate frequency and requests clearance to land at helipad B. ATC reviews the helipad operations and issues clearance to land. The PIC lands the helicopter.

Post-Operations Phase

The PIC advises ATC of landing assured. ATC acknowledges the PIC and discontinues monitoring of the flight.