UAM Concept Development Project

• Focus on crewed and uncrewed aircraft operations carrying passengers and cargo at lower altitudes in and around major metropolitan areas

• Address incorporation of UAM operations into the NAS, where traditional ATC and UTM operations exist

• Consider evolution of vehicle technology and increasing levels of automation
UAM Framework and Barriers

1. Airspace Design
2. Operational Rules, Roles, & Procedures
3. CNSI & Control Facility Infrastructure
4. UAM Port Design

1. Public Acceptance
2. Supporting Infrastructure
3. Operational Integration
4. Local Regulatory Environment & Liability

1. Safe Airspace Ops
2. Efficient Airspace Ops
3. Scalable Airspace Ops
4. Resilient Airspace Ops
5. Fleet Management
6. Urban Weather Prediction

1. Vehicle Design & Integration
2. Airworthiness Standards & Certification
3. Vehicle Noise
4. Weather-Tolerant Vehicles
5. Cabin Acceptability
6. Manufacturing & Supply Chain

1. Safe Urban Flight Management
2. Increasingly Automated Vehicle Operations
3. Certification & Ops Approval
4. Ground Ops & Maintenance

Aircraft & Aircrew Barriers
Airspace Barriers
Community Integration Barriers
Pillar number

Safety
Security
Affordability
Noise
Autonomy
UAM Ports
Regulations/Certification

FAA ConOps Focus Area
- **Infrastructure**
- **Operations**

**MATURE STATE**

- **UML-6**
  - Ubiquitous UAM Operations with System-Wide Automated Optimization
  - 10,000s of simultaneous operations (capacity limited by physical infrastructure); ad hoc landing sites; noise compatible with suburban/rural operations; private ownership & operation models enabled; societal expectation

- **UML-5**
  - High Density and Complexity Operations with Highly-Integrated Automated Networks
  - 1,000s of simultaneous operations; high-volume manufacturing; large-scale, highly-distributed networks; high-density UTM inspired ATM; autonomous aircraft and remote, M:N fleet management; high-weather tolerance including icing;

- **UML-4**
  - Medium Density and Complexity Operations with Collaborative and Responsible Automated Systems
  - 100s of simultaneous operations; expanded networks including high-capacity UAM ports; many UTM inspired ATM services available, simplified vehicle operations; low-visibility operations; Infrastructure expansions and scalability; local/state/municipal laws facilitate

- **UML-3**
  - Low Density, Medium Complexity Operations with Comprehensive Safety Assurance Automation
  - Operations into urban core; operational validation of airspace, UTM inspired ATM, CNS, C^2, and automation for scalable, weather-tolerant operations; closely space UAM pads, ports; noise compatible with urban soundscape; community engagement with infrastructure rollout

- **UML-2**
  - Low Density and Complexity Commercial Operations with Assistive Automation
  - Type certified aircraft; initial Part 135 operation approvals; limited markets with favorable weather and regulation; small UAM network serving urban periphery; UTM Construct and UAM corridors supporting self-managed operations through controlled airspace; permissive communities

- **UML-1**
  - Late-Stage Certification Testing and Operational Demonstrations in Limited Environments
  - Aircraft certification testing and operational evaluations with conforming prototypes; procedural and technology innovation supporting future airspace operations (e.g. UTM-inspired); contemporary operational constructs; community/market demonstrations and data collection/IPP Like

**INITIAL STATE**

- **UML-6**
  - Ubiquitous UAM Operations with System-Wide Automated Optimization
  - 10,000s of simultaneous operations (capacity limited by physical infrastructure); ad hoc landing sites; noise compatible with suburban/rural operations; private ownership & operation models enabled; societal expectation

- **UML-5**
  - High Density and Complexity Operations with Highly-Integrated Automated Networks
  - 1,000s of simultaneous operations; high-volume manufacturing; large-scale, highly-distributed networks; high-density UTM inspired ATM; autonomous aircraft and remote, M:N fleet management; high-weather tolerance including icing;

- **UML-4**
  - Medium Density and Complexity Operations with Collaborative and Responsible Automated Systems
  - 100s of simultaneous operations; expanded networks including high-capacity UAM ports; many UTM inspired ATM services available, simplified vehicle operations; low-visibility operations; Infrastructure expansions and scalability; local/state/municipal laws facilitate

- **UML-3**
  - Low Density, Medium Complexity Operations with Comprehensive Safety Assurance Automation
  - Operations into urban core; operational validation of airspace, UTM inspired ATM, CNS, C^2, and automation for scalable, weather-tolerant operations; closely space UAM pads, ports; noise compatible with urban soundscape; community engagement with infrastructure rollout

- **UML-2**
  - Low Density and Complexity Commercial Operations with Assistive Automation
  - Type certified aircraft; initial Part 135 operation approvals; limited markets with favorable weather and regulation; small UAM network serving urban periphery; UTM Construct and UAM corridors supporting self-managed operations through controlled airspace; permissive communities

- **UML-1**
  - Late-Stage Certification Testing and Operational Demonstrations in Limited Environments
  - Aircraft certification testing and operational evaluations with conforming prototypes; procedural and technology innovation supporting future airspace operations (e.g. UTM-inspired); contemporary operational constructs; community/market demonstrations and data collection/IPP Like
UAM Evolution

**Initial UAM Operations**
- Within the bounds of current ATM environment
- Requires no changes to rules and regulations
- Leverages existing routes and procedures

**Early UAM-Specific Operations**
- Occur within defined UAM Corridors
- Changes to current rules and regulations might be required
- Industry defined COPs may be required to meet FAA guidelines and be approved by the FAA

**Intermediate State UAM Operations**
- Use expanded UAM Corridors
- Changes to rules and regulations might be required
- Increased levels of automation and vehicle capability
# UAM Responsibilities

## Operator
- Coordinate, execute, and manage operations
- Comply with a set of stakeholder-developed Cooperative Operating Practices (COPs)
- Comply with applicable performance and regulatory requirements for the airspace within which they are operating
- Use airspace as efficiently as practical and do not knowingly impede other operators’ use of airspace
- Share intent information with other relevant stakeholders as required
- Maintain conformance to the intent communicated to other stakeholders

## Regulatory/ANSP
- Maintain regulatory authority over airspace and operations
- Provide guidelines and approves or acknowledges COPs in accordance with agency statutory responsibilities for equity, safety, and security
- Qualify third-party suppliers of services for use by UAM operators to meet regulatory requirements
- Establish performance requirements frameworks for cooperative airspace and confirm the operator meets the standardized level of performance
UAM Concept of Operations

- UAM Operations were defined as the transport of people or goods from one vertiport or airport to another using UAM Corridors.
- Any aircraft using or crossing a UAM Corridor participates in the UAM Ecosystem by obtaining a confirmed Operational Intent from a PSU.
- Aircraft operating within a UAM Corridor must meet the performance and participation requirements of the UAM environment.

While a good starting point, UAM Corridors in all airspace classes with a requirement to fully participate becomes restrictive.
1. UAM Corridor characteristics
   - **Impacted ATM Operations**: Some impact to ATM operations (average of 15 GA or helicopter impacted operations)
   - **Altitude**: Challenging – often lower than the target and led to inclusion of varying altitudes within a single UAM Corridors
   - **Distance**: Conformant to target, but not straight lines
   - **Height/Width Sensitivity**: Significant sensitivity to corridor height, less sensitivity to width

2. Airport Flow Impact
   - Locations available for UAM Corridors near airports is dependent upon the airport flow

3. NAS Trade-offs - No Green Space, there is a trade space of stakeholder needs
UAM Corridor Considerations

- Revisit three foundational assumptions from UAM ConOps 1.0
  - UAM Corridors would be required in all classes of airspace
  - Non-UAM aircraft would be required to share operational intent to cross UAM Corridors
  - UAM Corridors going all the way to the vertiport*

- Explore Concepts that:
  - Minimize impact to non-UAM crossings
  - Maximize flexibility/access for UAM
  - Mitigate impacts of UAM/non-UAM interactions
  - Provide scalable solutions for ATC interactions
  - Optimize overall integration objectives

*Research Ongoing
## UAM Corridor Expectations

<table>
<thead>
<tr>
<th>Airspace Class</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corridors Required?</td>
<td>Yes</td>
<td>Yes</td>
<td>As-required</td>
<td>IMC- yes VMC - eventually</td>
</tr>
<tr>
<td>Participation Requirements for Non-UAM Aircraft Crossing a UAM Corridor</td>
<td>Required Confirmed UAM Operational Intent</td>
<td>Prescribed (e.g., ADS-B Out, cross at designated points, predictable crossing trajectory (level flight, constant speed, no turns))</td>
<td>Moderate (e.g., ADS-B Out, cross at designated points, predictable crossing trajectory (level flight, constant speed, no turns))</td>
<td>Minimal (e.g., ADS-B Out)</td>
</tr>
<tr>
<td>UAM Tactical Capabilities within UAM Corridor</td>
<td>UAM Ecosystem baseline capability</td>
<td>UAM Ecosystem increased capability</td>
<td>UAM Ecosystem increased capability</td>
<td>UAM Ecosystem increased capability</td>
</tr>
</tbody>
</table>
UAM Architecture

- UAM Operations are organized, coordinated, and managed by a federated set of actors through a distributed network that leverages interoperable information systems.

- The PSU Network lies at the center of the UAM notional architecture and exchanges data with UAM Operators, USSs, SDSPs, the FAA, and Public Interest entities.

- Introducing UAM Vertiport and ATM Operator Crossing Class B as new actors.

- De-coupling from UTM Architecture.
UAM Activities

- One-on-One Listening Sessions I with Industry at NASA
- One-on-One Listening Sessions II Industry at NASA

2019

2020
- Initial set of Guiding Principles and Assumptions
- UAM Scenario Driven Guided Discussion
- FAA NextGen UAM ConOps v1.0 Released

2021
- Conducted Series of Engineering Analysis and research Analyses:
  - UAM Concept Maturation Plan
  - UAM Corridor Impact Assessment
  - Initial UAM Navigation performance Assessment Report

2022
- UAM Guided Discussion March 15, 2022
- Establishment of UAM Airspace Management Demonstration project August 3, 2022
FAA ConOps Development Next Steps

• Continue cross collaboration with NASA and Industry to refine ConOps v2.0

• Foundational work to support UAM Concept Maturation
  • Candidate research activities (e.g., UAM COPs Assessment, UAM Roadmap, Capability Analysis)
  • Mature and modify UAM ConOps through ongoing Government and industry stakeholder engagement
  • Develop common "use cases" that can be utilized across efforts in both Agencies
Thank you!