AAM Ecosystem Working Groups (AEWG):
Urban Air Mobility (UAM) Concept of Operations (ConOps)

Community Integration Breakout

July 10th, 2020
1:00pm-2:30pm EDT

The UAM vision will only be achievable if everyone benefits
## Agenda

**July 10th, 2020**

1:00pm-2:30pm

<table>
<thead>
<tr>
<th>Topic</th>
<th>Content</th>
<th>Presenters</th>
<th>Timing</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Welcome Introductions Overview</td>
<td>Rules for the Road</td>
<td>Nancy Mendonca</td>
<td>1:00-1:15</td>
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<td></td>
<td>Meeting Speakers</td>
<td>Dwight DeCarme</td>
<td>1:00-1:15</td>
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<td></td>
<td>Community Integration Pillar Overview</td>
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<td>1:00-1:15</td>
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<tr>
<td>Concept Deep Dive(s) Interactive Polling</td>
<td>Community Integration Pillar</td>
<td>Brian Hill</td>
<td>1:15-2:15</td>
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<td>Christine Griffin</td>
<td>1:15-2:15</td>
<td>0:60</td>
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<tr>
<td>Next Steps Questions</td>
<td>Next Steps Questions</td>
<td>Dwight DeCarme</td>
<td>1:15-2:30</td>
<td>0:15</td>
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</tbody>
</table>

Image Source: NASA UAM Grand Challenge Industry Day
Speakers, Objectives, & Logistics

Nancy Mendonca, National Aeronautical and Space Administration (NASA)
Deputy, AAM Mission Office, NASA COR

Yuri Gawdiak, National Aeronautical and Space Administration (NASA)
Airspace Operations & Safety Program Associate Director, ARMD, NASA HQ

Brian Hill, Deloitte
Specialist Master, Systems Engineering for Government & Public Sector Practice

Christine Griffin, Deloitte
Senior Consultant, Systems Engineering for Government & Public Sector Practice

Dwight DeCarme, Deloitte
Senior Consultant, Systems Engineering for Government & Public Sector Practice

Objectives
Engage
Elicit
Respond

Scope
This ConOps “Community Integration” breakout session is designed such that detailed, pillar-related content will be covered.

Logistics

Recording: This meeting is being recorded so it can be accessed at any time for watch back and for those that could not attend today.

Feedback received during the AEWG ConOps sessions will NOT be incorporated into Version 1.0 of the UAM ConOps
Poll
Conferences I/O

Polling is anonymous

Were you able to successfully join the Conferences I/O?
https://arc.cnf.io/sessions/hcbd/#!/dashboard

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Please keep Conferences I/O open throughout the duration of this presentation

Image Source: NASA UAM Grand Challenge Industry Day
Poll

Stakeholder Classification

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In which stakeholder group do you classify yourself?

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ConOps Overview Attendance

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Did you attend the UAM ConOps Overview Session on June 25th?

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Poll
ConOps Overview
Attendance

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Did you attend the UAM ConOps Vehicle Breakout Session on June 26th?

https://arc.cnf.io/sessions/hcbd/#!/dashboard
Urban Air Mobility Community Concept of Operations

Vision ConOps
(Structure Based on NASA UAM Framework)

- Community Integration
- Airspace System Design & Implementation
- Airspace & Fleet Operations Management
- Vehicle Development & Production
- Individual Vehicle Management & Operations

UAM Vision
Revolutionize mobility around metropolitan areas by enabling a safe, efficient, convenient, affordable, and accessible air transportation system

“Vision ConOps”
- High-level – Providing a vision of key concepts in the future
- Broad, covering all pillars

Scope
- Passenger-carrying operations
- Vision at the Intermediate state (UML-4)
- Placing air mobility within reach of the general public (i.e., realistic / cost effective transportation choice for general public)
## UAM Maturity Levels (UML)

### UAM Framework and Barriers

<table>
<thead>
<tr>
<th>UML</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td><strong>INITIAL STATE</strong></td>
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<tr>
<td>UML-1</td>
<td>Late-Stage Certification Testing and Operational Demonstrations in Limited Environments</td>
</tr>
<tr>
<td>UML-2</td>
<td>Low Density and Complexity Commercial Operations with Assistive Automation</td>
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<tr>
<td><strong>INTERMEDIATE STATE</strong></td>
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<tr>
<td>UML-3</td>
<td>Low Density, Medium Complexity Operations with Comprehensive Safety Assurance Automation</td>
</tr>
<tr>
<td>UML-4</td>
<td>Medium Density and Complexity Operations with Collaborative and Responsible Automated Systems</td>
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<tr>
<td><strong>MATURE STATE</strong></td>
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<tr>
<td>UML-5</td>
<td>High Density and Complexity Operations with Highly-Integrated Automated Networks</td>
</tr>
<tr>
<td>UML-6</td>
<td>Ubiquitous UAM Operations with System-Wide Automated Optimization</td>
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</table>

### 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); community/market demonstrations and data collection

### 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 routes supporting self-managed operations through controlled airspace

### UML-3: Low Density, Medium Complexity Operations with Comprehensive Safety Assurance Automation
- Operations include urban core; operational validation of advanced airspace operations and management including UTM inspired ATM, CNSI, C², and automation for scalable, weather-tolerant operations; few high-capacity vertiports; noise compatible with urban soundscape; model-local regulations

### UML-4: Medium Density and Complexity Operations with Collaborative and Responsible Automated Systems
- 100s of simultaneous operations; expanded networks including closely-spaced high throughput vertiports; many UTM inspired ATM services available, simplified vehicle operations for credit; low-visibility operations

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

### 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
UAM concept development relied on input from a diverse set of stakeholders across different mediums

<table>
<thead>
<tr>
<th>Subject Matter Expert Input from</th>
<th>Engagement of 100+ organizations through a series of two-day community workshops</th>
<th>Review of 160+ sources of UAM and UAM applicable literature (e.g., UAM, AAM, UAS, UTM, etc.)</th>
<th>Community-wide information sharing generating 1000+ comments and 800+ were incorporated</th>
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<tbody>
<tr>
<td>• NASA ARMD</td>
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<td>• FAA</td>
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<tr>
<td>• Deloitte Ecosystem Advisory Group</td>
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The 5 UAM Pillars divide the UAM concepts into various high-level categories. These pillars define the major areas of focus for the UAM concept.

**Pillar**
The 5 UAM Pillars divide the UAM concepts into various high-level categories. These pillars define the major areas of focus for the UAM concept.

**Barrier**
A barrier to realizing the UAM concept. These barriers break out the next level of detail within each pillar. The UAM concept is defined through the details associated with each barrier.

**UAM ConOps Content**
These bullets are the detailed, decomposed concepts as they pertain to each barrier. They represent the body of the ConOps and how the concept at UML-4.

**Remaining Unknowns**
The unknowns are the areas that require more detail and future research. These unknowns will require further investigation as the UAM concept matures.

This “vision” ConOps is a living document and will continue to be revised as concepts mature through research, development, and UMLs 1-3.
U4-UAM is a value added, integrated component of a city/region’s multi-modal transportation system and is part of local/regional transportation plans.

Cohesive federal, state, and local roles and authorities support design and development of air and ground UAM infrastructure.

Effective processes established to engage and consider community integration concerns (e.g., safety, noise, visual, privacy).

Infrastructure meets industry standards, local ordinances, and other regulations.

Infrastructure integrates advanced technologies to support UAM operations (e.g., grid/power capacity, security, ground transportation, weather sensing, and navigational infrastructure).

Key UAM Elements of Community Integration at UML-4
Community Integration

Scope and Focus

Barriers
- Public Acceptance
- Supporting Infrastructure
- Operational Integration
- Local Regulatory Environment & Liability
Concept Insights & Questions

As the concepts are presented through the course of this presentation, we would like you to keep the following in mind:

- Please rate your familiarity with the Draft NASA UAM ConOps
- Which of the Community Integration unknowns are the highest priority?
- Which Community Integration concepts require immediate investigation?
- Are there any additional high level barriers for Community Integration that should be addressed in this ConOps?
- How long do you think it will take to enact key policies and regulations?
- For the Community Integration concepts, what year will UML-4 be realized?
- For future sessions, should the format and audience size be adjusted to accommodate greater interaction?
- Specific questions associated with the concepts within the Community Integration pillar and barriers
Poll

Draft NASA ConOps
Familiarity

Polling is anonymous

Please rate your familiarity with the Draft NASA UAM ConOps

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Achieve public acceptance of UAM vehicle operations in and around metropolitan areas by addressing UAM-related social concerns such as safety, security, affordability, noise, privacy, and liability.

Barriers
- Public Acceptance
- Supporting Infrastructure
- Operational Integration
- Local Regulatory Environment & Liability
Community Integration

Barrier: Public Acceptance

Achieve public acceptance of the UAM concept overcoming concerns regarding safety, demonstrating public benefit, and addressing community and environmental impacts.

NASA Community ConOps

- The foundation built at UMLs 1-3 enables safe passenger-carrying operations at UML-4.
- The UAM industry builds confidence by proactively identifying hazards and their safe resolutions.
- Employment by UAM manufacturers, operators, PSUs, SDSPs and others in the UAM ecosystem creates a equitable mix of technical and non-technical jobs and spurs economic development.
- Successful demonstration of UAM at earlier UMLs of operations such as medical transport proves the concept and enables greater public acceptance at UML-4, which leads to higher passenger usage (which will drive down cost on a per ride basis) and decrease public resistance.
- UAM enables metro commuters to travel farther and faster than today, potentially reducing commuter time and congestion.
- At UML-4, vehicles are quieter than previous UMLs due to the evolution of technology.
- Regulators will have established vehicle and fleet noise standards and worked with communities to address localized concerns through flight route planning, temporal modifications, and flight procedures.
- Mitigating privacy concerns occurs through effective community engagement and builds upon privacy policies being developed for unmanned aircraft systems (UAS) today.
- Emission levels conform with existing standards and development of new standards is iterative and compliant with regulations.

Areas with Remaining Unknowns

- Public Familiarity with UAM
- Emissions Standards
- Economic Impact
- Mitigating Visual Impacts
- Noise Standards
- Demonstrating Affordability
- Demonstrating Safety
Develop and implement the required supporting infrastructure for integrating UAM operations into metropolitan areas, including utilities, data networks, and Vertiports.

**NASA Community ConOps**

- The physical infrastructure for vertiports, navigation, and data networks can be *publicly owned*, *privately owned*, or part of a *public-private partnership*.
- Municipalities, operators, and utility companies *cooperatively* determine how much *infrastructure investment* is required to sustain a UAM market, and decide who bears the costs.
- Operators *coordinate with municipalities and utility companies* to ensure *sufficient power* is available for vehicle charging operations.
- Emergence of new and innovative *partnership models* between UAM operators and energy companies may offer opportunities to simultaneously *satisfy energy needs* and *incorporate alternative energy sources*.
- UML-4 includes UAM “*purpose-built*” vertiport structures in addition to *preexisting, repurposed* vertiports (e.g., a heliport retrofitted to be a vertiport or one that serves both helicopters and UAM vehicles).
- Vertiports are designed and built with safety and security infrastructure in place to ensure safety and security for passengers.
- *Passenger demand* and *scalability* are critical for determining *vertiport location & infrastructure requirements*.
- Communities can control UAM growth areas via *zoning* ordinances.

**Areas with Remaining Unknowns**

- Financing Infrastructure Upgrades
- Data Network Ownership & Responsibility
- Energy Infrastructure Requirements
Community Integration

Barrier: Operational Integration

Implement multi-mode transportation integration and address operations-related community impacts, including passenger/cargo security, protection from malicious use of vehicles and denial of service attacks, and graceful degradation of the transportation ecosystem in reaction to disruption of UAM services.

NASA Community ConOps

- At UML-4, operational integration creates opportunities to integrate UAM with other transportation modes, including autonomous cars, to allow for a seamless transportation experience.
- Advanced security technologies expedite passenger and cargo screening.
- UAM ecosystem is built to address the vulnerabilities of automated systems and includes safety measures to defend against and mitigate threats such as cybersecurity attacks.
- The transportation ecosystem at UML-4 includes mitigation strategies to account for service disruptions on any particular mode, such as strategically placing vertiports in order to prevent overloading of any single mode of transportation in event of service disruption and graceful degradation of the entire transportation ecosystem in event of disruption of one or more of the various modes.

Areas with Remaining Unknowns

- Multi-Modal Integration
- Cybersecurity
- Security Screening & Boarding
Enact laws and regulations for governing UAM operations, such as zoning, privacy, and noise, striving for consistency across operating locations (i.e., states, municipalities) and develop a framework for the analysis of liability associated with the development and operation of increasingly automated and autonomous systems.

- The legal and regulatory framework and case law incorporates the roles and authorities of each: FAA, DOT, other federal agencies (e.g., EPA and FCC), state government, and local/city/municipal government.

- FAA maintains its role as federal regulator, and while federal preemption applies, rules that do not conflict with, or occupy the “field” of, a federal regulation/regulator may be promulgated at the state and/or local level.

- Because UAM vehicles operate so close to where people live and work, much local involvement and public interest in the rulemaking process surrounding UAM is anticipated.

- By UML-4, FAA and industry have improved forums and processes used in 2010s to engage state and local leaders to a greater extent than they did in the 2010s in order to harmonize regulations/ordinances promulgated at the state and local level avoiding a patchwork of rules.

- Communities maintain their power to control the development of ground infrastructure (vertiports, weather sensors, etc.) through zoning ordinances and noise through noise ordinances.

- Laws and other means to assign liability will be based upon current common carrier liability principles and will be updated to address the utilization of autonomous systems.
## Community Integration

### Unknowns

<table>
<thead>
<tr>
<th>Category</th>
<th>Question</th>
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<tbody>
<tr>
<td>Public Familiarity with UAM</td>
<td>How can the public be made aware of UAM’s benefits in order to promote public acceptance?</td>
</tr>
<tr>
<td>Demonstrating Safety</td>
<td>How can UAM stakeholders demonstrate UAM safety?</td>
</tr>
<tr>
<td>Noise Standards</td>
<td>How can public concern regarding noise be mitigated? Will the public’s threshold of acceptability for UAM-related noise be different than their threshold for noise created by commercial aviation?</td>
</tr>
<tr>
<td>Mitigating Visual Impacts</td>
<td>How can stakeholders respond to public concern regarding visual noise created by UAM operations and vertiports?</td>
</tr>
<tr>
<td>Energy Infrastructure Requirements</td>
<td>What tools or analyses can municipalities use/perform to determine how much energy infrastructure is needed to support a metropolitan UAM market?</td>
</tr>
<tr>
<td>Financing Infrastructure Upgrades</td>
<td>How can public-private partnerships be utilized in financing infrastructure and vertiports for UAM? Is this the best solution? What alternatives are available?</td>
</tr>
<tr>
<td>Multi-Modal Integration</td>
<td>What needs to occur to enable operational integration of UAM with other forms of transportation?</td>
</tr>
<tr>
<td>Security Screening &amp; Boarding</td>
<td>How will passengers and cargo be screened and processed at vertiports?</td>
</tr>
<tr>
<td>Federal and Local Government Engagement</td>
<td>How can federal regulators better engage local government as the UAM ecosystem develops? What about the reverse?</td>
</tr>
</tbody>
</table>
Poll

Community Integration Unknowns

Polling is anonymous

Which of the Community Integration unknowns are the highest priority? (select 3)

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Poll
Immediate Investigation

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Which Community Integration concepts require immediate investigation? (select 3)

*Thing that are hard to do and are long lead*

[https://arc.cnf.io/sessions/hcbd/#!/dashboard](https://arc.cnf.io/sessions/hcbd/#!/dashboard)
Poll

Are there any additional high-level barriers to Community Integration that should be addressed in this ConOps?

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The UAM ConOps is a living document that coincides with the maturation of the UAM concept. These concepts and associated documentation will be updated at appropriate intervals. Updates could also align with results from research, test, industry trends, federal/city/state/local policy and regulations, and community input.

**ConOps Version 1.0 Release**
- The UAM Community ConOps Version 1.0 release is targeted for July of 2020.
- This document will be released into the public domain and serve as the “Vision” ConOps for UAM at UML-4.

**AAM Ecosystem Working Groups**
- Each AEWG will address domain specific UAM concepts.
- The AEWGs will serve as the main forum for concept discussion, feedback, and forward work.

**UAM Concept Maturation**
- UAM concepts will mature as government, academia, industry, & community coalesce.
- As various UAM activities are realized, such as research & test, the UAM concepts will be updated.
Poll
Policy & Regulation Development Timeline

How long do you think it will take to enact key policies and regulations?

Can be Federal or Local. Looking to determine long lead items

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Poll

UML-4 Realization

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For the Community Integration concepts, what year will UML-4 be realized?

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Poll

Future Sessions - Format

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For future sessions, should the format and audience size be adjusted to accommodate greater interaction?

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THANK YOU

This recording and materials can be found on the NARI website in the next few days