ATM-X UAM Subproject
Principal Engineer, Dr. Ian Levitt
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Provide a high level overview of ATM-X UAM Subproject, and NASA’s Advanced Aerial Mobility (AAM) mission.
NASA Critical Commitment

AAM MISSION
Advanced Air Mobility (AAM)

- Includes “rural” and “urban” applications
  - Cargo transport, pax-carrying, aerial work, etc.
  - eVTOL, sUAS, eCTOL, hybrid-electric, etc.
  - Urban Air Mobility (UAM) as a challenging use-case with high benefit

- Enabled by electrification and automation

- Does not include:
  - Supersonic or hypersonic transport
  - Existing hub-and-spoke air service with large transport aircraft

Safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions

Local mission < ~75nmi, and intraregional mission < ~300nmi
Aircraft, airspace, and infrastructure system and architecture requirements to enable scalable medium density operations.
UAM Maturity Levels (UMLs): Top-Level View

- **UML-1 (Mature certification projects)**
- **UML-2 (Initial commercial operations)**
- **UML-3 (Early adopter markets, initial fleet operations)**
- **UML-4 (Scalable, weather-tolerant operations for any city)**
- **UML-5 (Widespread deployment)**
- **UML-6 (Ubiquitous on-demand air mobility)**
ATM-X Project

UAM AIRSPACE SUBPROJECT
ATM-X Project Organization

Air Traffic Management – eXploration

Project Office
Project Manager: William Chan
Deputy Proj. Mgr.: Mike Madson
Deputy Proj. Mgr. - Tech: Dr. Bryan Barmore
Chief Engineer: Dr. Joey Rios

System Engineering
Lead: Dr. James Chartres
Risk Mgr: Joshua Moody

Project Support
Coordinator: Roxana Corzo
Lead Analyst: Warcquel Frieson
Center Analysts: Brenda McKay, Meredith Irwin
Schedulers: Natalie Condon, Donna Gilchrist

ARD Office
ARC APM: Lindsay Stevens
LARC APM: Dr. Taumi Daniels
GRC APM: Rafael Apaza

Vision 2045
Lead: Shawn Engelland

Management approach governed by NPR 7120.8A

Digital Information Platform – (DIP)
SPM: Mirna Johnson

UAM Airspace Management (UAM)
SPM: Kevin Witzberger
DSPM: Arwa Aweiss
PE: Dr. Ian Levitt

Pathfinding for Airspace with Autonomous Vehicles (PAAV)
SPM: Rob Fong
TL: Kurt Swieringa

Collaborative Traffic Management (CTM)
SPM: Dr. Jaewoo Jung
TL: Dr. Min Xue

SUB-PROJECTS
Work Package 1: Urban Air Mobility Foundational Research

• **Task 1.1: UAM Demand Analysis**
  – The objective of this task is to identify potential demand for Urban Air Mobility (UAM) in cities/urban areas, in suburban areas/regions, between nearby cities/regions.
    • Jeremy Smith, jeremy.c.smith@nasa.gov

• **Task 1.2: UAM Network**
  – The objective of this task is to develop the necessary knowledge to quantify and qualify the advantages and disadvantages of different designs for a UAM network designs utilizing cost functions, network scheduling algorithms, and UAM demand prediction models.
    • Hanbong Lee, hanbong.lee@nasa.gov

• **Task 1.3: UAM Impacts Analysis**
  – The objective of this task is to develop fast-time simulated system-level impact assessments of weather and localized sub-system failures on potential UAM operations and environmental impacts due to UAM operations in selected urban/rural areas.
    • Hokkwan Ng, hokkwan.ng@nasa.gov

• **Task 1.4: UAM Flight Performance**
  – The objective of this task is to develop a database for typical Urban Air Mobility (UAM) vehicles especially considered as V/STOL configurations will be used for the development and analysis of UAM-concepts dedicated to various urban regions and operational concepts.
    • John Foster, John.v.foster@nasa.gov
UAM SPM

Airspace Systems Architecture, Engineering and Management
Principal Engineer: Ian Levitt (ian.m.levitt@nasa.gov)
Lead Systems Engineer: Annie Cheng (annie.w.cheng@nasa.gov)

Separation Standards
ARC Tech Lead: Seungman Lee
LaRC Tech Lead: Maria Consiglio

Airspace Procedures & Design
ARC Tech Lead: Savvy Verma

Airspace Services
ARC Tech Lead: Heather Arneson
LaRC Tech Lead: Nelson Guerreiro

Airspace Integration, Testing & Demonstration (AIT&D)
ARC Tech Lead: Spencer Monheim
LaRC Tech Lead: Heidi Glaudel
UAM Airspace Evolution

“Airspace is ready when the Vehicle is ready”

- Airspace domain has many components
- Each component evolves through the UML progression
  - Need to see how to get there from here
Notional UAM Architecture (FAA NextGen Conops v1.0)
BACKUP
Backup Slides

AAM MISSION
AAM Mission Critical Commitment

Vehicle Development and Operations Develop concepts and technologies to define requirements and standards addressing key challenges such as safety, affordability, passenger acceptability, noise, automation, etc.

Airspace Design and Operations Develop UTM-inspired concepts and technologies to define requirements and standards addressing key challenges such as safety, access, scalability, efficiency, predictability, etc.

Community Integration Create robust implementation strategies that provide significant public benefits and catalyze public acceptance, local regulation, infrastructure development, insurance and legal frameworks, etc.

Achieving a “validated system architecture” will require enabling activities such as 1) the AAM National Campaign Series 2) a robust Ecosystem Partnership model and 3) NASA ARMD Portfolio Execution.

Critical Commitment:
Based on validated operational concepts, simulations, analyses, and results from National Campaign demonstrations, the AAM Mission will deliver aircraft, airspace, and infrastructure system and architecture requirements to enable sustainable and scalable medium density advanced air mobility operations.
NASA AAM Mission Priorities

Human Response to Noise (RVLT)
Regional M&S Capabilities (ATM-X)
Assured Automated Architectures (ATM-X)
Automated Flight and Contingency Management (AAM)
Fleet Wide Supervisory Control (TTT-AS)

In-time Aviation Safety Management System (SWS)
Airspace & Fleet Operations Management
Vehicle Development & Production
Individual Vehicle Management & Operations
Airspace System Design & Implementation
Community Integration

System and Architectures Reqts (AMO)
National Campaign (AAM)
Fleet Wide Supervisory Control (TTT-AS)
High Density Microplex (AAM)

Source and Fleet Noise (RVLT)
Vehicle Propulsion Reliability (RVLT)
Safety in Environmental and Failure conditions (RVLT)
Distributed Electric Propulsion (FDC)
Comm Nav Surveillance Information (ATM-X)
Operational Rules, Roles, & Procedures (ATM-X)

Lead Project Legend
AAM
ATM-X
RVLT
SWS
FDC
TTT
AMO
AAM Reference Framework & Deliverables Supporting the Critical Commitment

Collaborating with other federal/state/local governments and industry organizations across the AAM Ecosystem to develop a comprehensive set of AAM system and architecture requirements for medium density operations.

**Ecosystem Contributions**

- Vision & Guiding Principles
- Applicable Standards & Regulations
- Community Assessment
- Assumptions & Constraints
- Supporting Data, Rationale & Evidence
- Parametrics
- ConOps & Use Cases
- Common Dictionary / Taxonomy
- System Requirements
- System Architectures
- AAM Mission Critical Commitment

**Critical Commitment Deliverables**

- Candidate UAM System Concepts & Architectures
- Simulation and Flight Test Data & Evidence
- Relevant Data Exchanges
- NASA research, development, test & validation

**MBSE** = Model Based Systems Engineering
AAM Ecosystem Working Groups (AEWG)

Accelerate the development of safe and scalable AAM flight operations by bringing together the broad and diverse community involved in developing this new capability.

- Align on a common vision for AAM
- Learn about NASA’s research and planned transition paths
- Adopt a strategy for engaging the public on AAM
- Collectively identify and investigate key hurdles and associated needs
- Develop AAM system and architecture requirements
- Support regulatory and standards development

Form a connected stakeholder community
NASA/FAA AAM WG Structure

- Executive leadership has jointly agreed to a WG structure to continue formalizing AAM planning and execution strategies
- Multiple working groups are extensions of previous collaborations
- All working groups have been through an iteration of a cross-agency planning cycle
NATIONAL CAMPAIGN
Goal

Assure AAM safety and accelerate scalability through integrated demonstrations of candidate operational concepts and scenarios.

Objectives

1. Accelerate Certification and Approval
2. Develop Flight Procedure Guidelines
3. Evaluate the CNS Trade-Space
4. Demonstrate an Airspace Operations Management (AOM) Architecture
5. Characterize Community Concerns
Help catalyze UML 1, 2...

Key enablers to accelerate the UML 3&4 timeline...

Remain Agile... Assess and align the AAM strategy with industry needs

UML "unlocks" based on a range of publicly available industry projections and conversations with partners; not a consensus view.
NC DT – Scenarios 1-3

• Scenario 1: Nominal Integrated Flight Operations
  – Nominal flight planning for a flight with no activated contingencies
    • Flight planning, route negotiation and acceptance, route and time conformance
    • Simulated background traffic to study impacts on timing

• Scenario 2: Integrated Flight Operations with an Activated Contingency
  – Nominal point-to-point route, then a temporary flight restriction (TFR) requires the vehicle to re-route while en route
  – Leveraging airspace test infrastructure based on a UTM construct for initial flight plan submission and test re-route from the airspace perspective

• Scenario 3: Terminal Operations and Approach/Landing Contingencies
  – 3a: Airspace initiates the contingency; go-around, loiter, and land at original site
  – 3b: Vehicle initiates the contingency; balked landing and divert to an alternate site
  – 3c: Vehicle initiates the contingency; vehicle executes a go-around, requests immediate landing, and ATC works vehicle into simulated traffic to land on an active runway
Backup Slides

RESEARCH, DEVELOPMENT, TEST & EVALUATION CAPABILITIES
NASA AAM Facilities and Capabilities

* This list of capabilities is a notional first cut and we are still in formulation, we have not yet assessed all the requirements or made commitments for each capability.
NASA AAM Facilities and Capabilities Cont.

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Strong Domestic eVTOL Industry Base

- Bell
- Beta
- Boeing/Aurora
- Etroy Air
- Joby
- Jaunt Air
- Kitty Hawk
- Wisk
- Workhorse/Moog