Federal Aviation Administration

FAA Drone Integration

FAA Unmanned Aircraft Systems (UAS) Integration Research Update

April 12, 2023

Strategic Outlook for Cross-Cutting Research in Emerging Operations: UAS and AAM

Purpose for Research: Informs UAS and AAM data-driven policy decisions, safety assessments, rulemaking, and standards to enable the FAA to safely get to YES.

Completed to Date

Lessons learned from operations, rules, and prior research:

- Collision severity
- Counter UAS
- Detect and Avoid (DAA)
- UAS aerospace forecasting
- Multi-UAS operations
- Human factors
- Waiver trend analysis
- Command and Control (C2) link and Communications

2023-2028 Near Term

UAS & AAM Research being conducted/planned:

- Aircraft safety and certification
- Beyond Visual Line of Sight operations
- Detect and Avoid (DAA)
- Airborne collision severity and likelihood
- Cyber and data security
- Command and Control (C2) link and Communications
- Human factors
- Forecast and impact of increasingly advanced UAS operations
- Safe on-airport UAS applications (e.g., runway inspections, perimeter monitoring)
- Counter UAS in airport environment and off airport
- Environment (e.g., noise, emissions)
- STEM for future aviation workforce
- Community engagement and acceptance

OUTCOME FOCUSED: Data to inform UAS and AAM policy decisions, rulemaking, training & qualifications, and performance-based standards to enable the FAA to safely get to YES.

2029-2034 Mid Term

Research areas that are of interest, need, or consequence:

- AAM/UAM traffic management: capacity of UAM flight corridors
- Cyber and data security: third party providers of services, link security
- Human factors: passenger interface with autonomous vehicles, off-nominal operations
- Training and qualifications for off-nominal operations
- Airport/vertiport infrastructure
- Counter UAS
- Forecast and impact of increasingly advanced AAM operations
- AAM/UAM concept maturation by domestic and international partner research
- Environment

RESEARCH DRIVERS: (what do we expect operations to look like in the midterm) – routine BVLOS operations, large AAM/UAM aircraft, scalability of operations and capacity of UTM/USS/ATM, operational approvals/tempo

- Certified eVTOL vehicles
- Data to inform large UAS and AAM policy decisions, rulemaking, training & qualifications, and performance-based standards

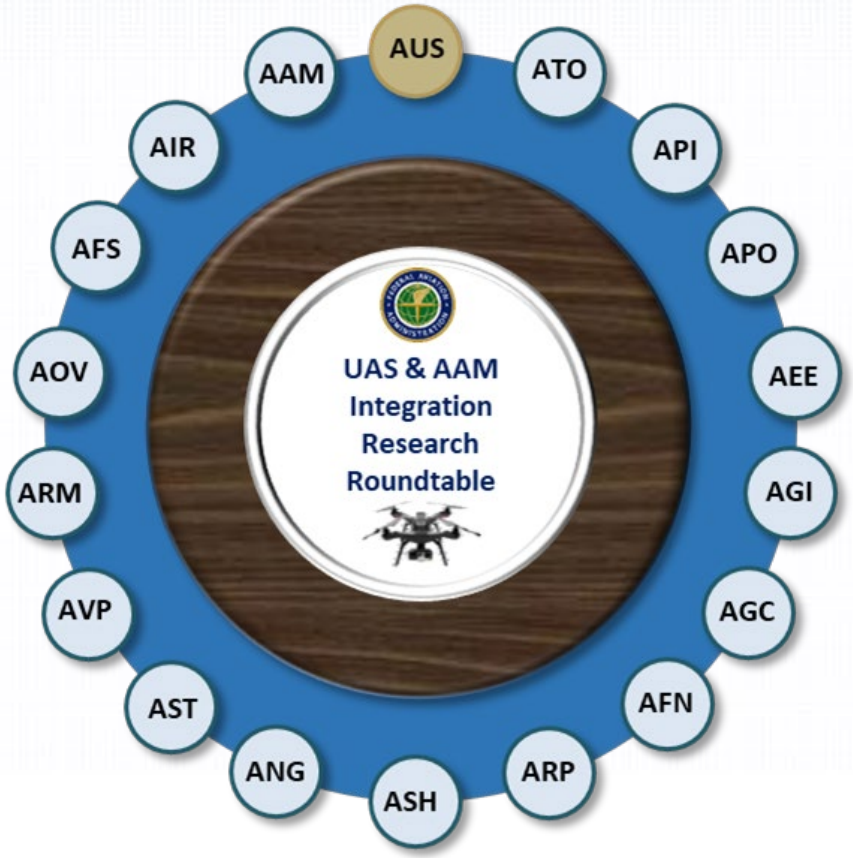
2035-2040 Far Term

Anticipated changes and technologies that may affect the aviation industry:

- Advanced Air Mobility (AAM)
- Automated/fully autonomous operations
- Passenger transport operations
- Artificial Intelligence (AI)/Machine Learning (ML) certification

FAA UAS and AAM Integration Research Stakeholders & Partners

FAA Drone Integration



Federal Partners (EXCOM, SARP)

Advanced Air Mobility/Urban Air Mobility

UAS Center of Excellence
ASSURE

FAA WJHTC

FAA CAMI

Industry
Advanced Aviation Advisory Committee (AAAC)
Partnership for Safety Program (PSP)
Integration Partnership Agreement (IPA)
UAS Aviation Rulemaking Committees
Drone Safety Team (DST)
BEYOND

UAS Test Sites
University of Alaska Fairbanks
Griffiss International Airport (NY)
State of Nevada
New Mexico State University
North Dakota DOC
Texas A&M Univ. Corpus Christi
Virginia Polytechnic Institute

MITRE CAASD

DOT Volpe

Standards Groups
ANSI
ASTM International
IEEE
ITU
NIST
RTCA
SAE International

International Partners
International CAAs
International Research Institutes
SESAR
ICAO
EASA
JARUS
EUROCAE
CANSO
NATO

Research Organizations
National Academy of Public Administration
National Academies of Sciences, Engineering, and Medicine
MIT / LL
REDAC

Responses to REDAC Full Committee Comments on FAA UAS & AAM Integration Research Plan Edition 5 (2021-2026) from Closed Session on November 18, 2022

Aircraft Safety (1 of 3)

- **Comment:** How is earlier research guiding later work in an advanced phase?
  - **Response:** Every FAA research project starts with a literature review of prior research, both internal and external to the FAA. The results of this review are used to guide future research.

- **Comment:** High value applied research is needed in areas such as: artificial intelligence (AI)/machine learning (ML) certification and pilot requirements.
  - **Response:** We are working to represent AI/ML in our research framework. Our strategic outlook reflects these areas for research.

- **Comment:** Cyber was called out many times as a “gap” but is addressed in only 4 research outcomes. Cyber research needs more emphasis and should be moved to the left.
  - **Response:** Cyber research is captured in our near term planning as reflected in our strategic outlook.

Aircraft Safety (2 of 3)

- **Comment:** The large volume of weather research needs to be reviewed.
  - **Response:** Across the domains, FAA is working to define a research accountability framework. This is an area that we reviewed and agree that determining safe weather conditions for any aircraft in the NAS is the responsibility of the operator.

- **Comment:** NASA is conducting significant human factors research.
  - **Response:** We have a strong partnership with NASA and work closely with them to align UAS & AAM research planning efforts, including human factors research.

- **Comment:** Increase clarity of commercial space operations within the context of the Research Plan.
  - **Response:** We work closely with all lines of business across the FAA, including Commercial Space Transportation (AST), to accurately represent their domain. We have received official sign-off on this representation, but we will revisit in the next edition of the Research Plan.

Aircraft Safety (3 of 3)

- **Comment:** Recommend that FAA review the National Academies report on Assessing Risks of UAS.
  - **Response:** AVS/AUS commissioned the National Academies study in response to the FAA Reauthorization Act of 2016. The FAA continues to consider the National Academies report.

- **Comment:** There are opportunities to leverage relevant research external to the FAA.
  - **Response:** We maintain a robust domestic and international partnership network with industry, civil aviation authorities, academia, U.S. federal agencies, standards development organizations, research and development institutes, and continue to leverage research undertaken by our partners.

- **Comment:** Timelines should reflect UAS advancements.
  - **Response:** Our strategic outlook for research reflects anticipated advancements in a rolling five-year window; the next edition of the UAS & AAM Integration Research Plan (2023-2028) will have revised timelines showing more granularity, linkages, and interdependencies.

Airports (1 of 2)

- **Comment:** Additional challenges may be addressed through research, including noise, flight over communities, and operations on airports.
  - **Response:** Our strategic outlook addresses these areas of research.

- **Comment:** Clarify research timelines to indicate how research efforts are aligned with one another and with industry expectations.
  - **Response:** Our strategic outlook for research reflects anticipated advancements in a rolling five-year window; the next edition of the UAS & AAM Integration Research Plan (2023-2028) will have revised timelines showing more granularity, linkages, and interdependencies.

- **Comment:** Current UAS and AAM research being conducted within the Airport Technology R&D Program has yielded beneficial results.
  - **Response:** We assess and prioritize the research needs of all lines of business across the FAA, including the Office of Airports (ARP), and partner with ARP to leverage and not duplicate the research and results within this program.

Airports (2 of 2)

- **Comment:** Airport operations and alignment with current airport technology research should be discussed in the Plan.
  - **Response:** We agree that this is an important area and is identified on our strategic outlook. We continue to engage with the Office of Airports (ARP) and the Airport Technology R&D Program on current and future research and its application to integration.

- **Comment:** There is a large volume of background information, including the partner organization summaries.
  - **Response:** In the early editions of the FAA's UAS Integration Research Plan, we were trying to assist the reader with understanding the research landscape and partnerships for UAS integration. Now that we have progressed, we plan to move a significant portion of the background information to appendices and focus on the planning aspects in the main document.

- **Comment:** There are opportunities to include additional FAA planned research and to enlist subject matter expertise to inform airport-focused research.
  - **Response:** We assess and prioritize the research needs of all lines of business across the FAA, including the Office of Airports (ARP). The Office of Airports has a robust partnership network to include airport operators and subject matter experts. For all of our UAS and AAM research, we have a long history of collaborating with subject matter experts across different domains.

Environment and Energy

- **Comment:** Suggest adding an executive summary to assist in capturing feedback.
  - **Response:** We will develop a standalone executive summary that summarizes UAS and AAM integration research at a high level, as part of the next publication cycle of the Plan. The full Plan captures critical details including our robust partnership network, and descriptions of UAS and AAM research. We continue to identify additional opportunities for presenting information concisely in the Plan.

- **Comment:** Clarify how projects feed into other projects or were dependent on others.
  - **Response:** Our strategic outlook for research reflects anticipated advancements in a rolling five-year window; the next edition of the UAS & AAM Integration Research Plan (2023-2028) will have revised timelines showing more granularity, linkages, and interdependencies.

- **Comment:** There are additional opportunities for research in areas such as noise impacts, operations in the vicinity of existing airports, and unauthorized operations.
  - **Response:** We assess and prioritize the research needs of all lines of business across the FAA, including the Office of Environment and Energy (AEE). These areas of research have always been a part of our research portfolio. Our strategic outlook continues to reflect these areas of research.

Human Factors (1 of 3)

- **Comment:** There are additional opportunities for high-value applied research in areas such as automation and training.
  - **Response:** We are conducting research on AAM & UAM safe automation, best practices for UAS automated systems, and remote pilot & crew training. Our strategic outlook reflects these areas for research.

- **Comment:** Although the plan seems comprehensive, the details of the implementation of the plan are important and should be developed further.
  - **Response:** This is the FAA's comprehensive plan for UAS and AAM integration research, coordinated across the agency with all lines of business. Each line of business uses the results of their sponsored research within this portfolio to inform their responsibilities for safe and secure integration.

- **Comment:** Consider leveraging the Technical Training and Human Performance COE for training research.
  - **Response:** The FAA's Center of Excellence for UAS, ASSURE, is our partner for all UAS and AAM research conducive to academia. ASSURE has always had the requirement and ability to perform research in the area of training.

Human Factors (2 of 3)

- **Comment:** Assess community impact of UAS/AAM operations.
  - **Response:** Community engagement and acceptance is key to enabling the integration of UAS and AAM operations. This is included in our near-term strategic outlook. The state, local, and tribal government partnerships through the operational pilot programs have incorporated community engagement.

- **Comment:** Monitor and assess ongoing UAS/AAM activities in other parts of the world to learn from potential issues and successes.
  - **Response:** The inaugural FAA International UAS and AAM Integration Research Roundtable was held in 2019, and has been reflected in all our Research Plan editions to date. Our participants include civil aviation authorities and research organizations from over 17 different countries and regions.

Human Factors (3 of 3)

- **Comment:** There are opportunities to leverage research from external organizations.
  - **Response:** We maintain a robust domestic and international partnership network with industry, civil aviation authorities, academia, U.S. federal agencies, standards development organizations, research and development institutes, and continue to leverage research undertaken by our partners.

- **Comment:** Timelines need to reflect priority and implementation plans for research.
  - **Response:** Our strategic outlook for research reflects anticipated advancements in a rolling five-year window; the next edition of the UAS & AAM Integration Research Plan (2023-2028) will have revised timelines showing more granularity, linkages, and interdependencies. It will also highlight the current and planned research expected outcomes and application to safe & secure integration.

NAS Operations (1 of 2)

- **Comment:** Define AAM and how it relates to UAS.
  - **Response:** AAM means “a transportation system that transports people and property by air between two points in the United States using aircraft with advanced technologies, including electric aircraft or electric vertical take-off and landing aircraft, in both controlled and uncontrolled airspace” (Source: Public Law 117-203). In coordination with industry, it has been determined that the near-term AAM capability will be piloted. But the future concept for AAM relates to UAS with the inclusion of remotely piloted and/or fully autonomous operations.

- **Comment:** Timelines need to define specific milestones and interdependencies.
  - **Response:** Our strategic outlook for research reflects anticipated advancements in a rolling five-year window; the next edition of the UAS & AAM Integration Research Plan (2023-2028) will have revised timelines showing more granularity, linkages, and interdependencies. It will also highlight the current and planned research expected outcomes and application to safe & secure integration.

- **Comment:** There is a large volume of background information, including the partner organization summaries.
  - **Response:** In the early editions of the FAA’s UAS Integration Research Plan, we were trying to assist the reader with understanding the research landscape and partnerships for UAS integration. Now that we have progressed, we plan to move a significant portion of the background information to appendices and focus on the planning aspects in the main document.

NAS Operations (2 of 2)

- **Comment:** There are opportunities for high-value applied research in areas such as: navigation, communications, artificial intelligence (AI)/machine learning (ML) certification, weather services, and Regional Air Mobility.
  - **Response:** Our portfolio includes active and completed research on navigation systems, C2 link and communications, and emerging AAM markets such as Urban Air Mobility UAM & Regional Air Mobility. In addition, we are working to represent AI/ML in our research framework. Our strategic outlook reflects these areas for research. Across the domains, FAA is working to define a research accountability framework. Weather is an area that we reviewed and agree that determining safe weather conditions for any aircraft in the NAS is the responsibility of the operator.

- **Comment:** Leverage external research in areas such as detect and avoid (DAA) performance standards.
  - **Response:** Our portfolio includes active and completed research on DAA. Our strategic outlook also reflects this research area. We have a robust partnership network and continue to leverage UAS and AAM research efforts, such as DAA performance standards, undertaken by our partners.

FAA Drone Integration

THANK YOU!