A2.03 Advanced Air Mobility (AAM) Integration

Lead Center: HQ

Participating Center(s): LaRC

Scope Title

Support Community AAM and Community Engagement Planning

Scope Description

AAM is a concept for safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions. AAM includes many potential mission types (e.g., passenger transport, aerial work, and cargo transport) that may be accomplished with many different aircraft types (e.g., manned, and unmanned; conventional, short, and/or vertical takeoff and landing; all electric and hybrid electric; etc.) and are envisioned to bring aviation into people's daily lives. Although passenger-carrying urban air mobility (UAM) is an AAM mission with much investment, other AAM missions, including but not limited to thin haul and regional air mobility, small package delivery, and medical transport, are also of interest. Responses to this subtopic are not limited to strictly any single AAM mission.

The AAM ecosystem can be viewed as being comprised of three pillars: vehicle, airspace, and community. For this discussion community consists of governmental decision makers and those that support them. Significant investment is being made in local vehicle manufacturing companies, and some investment is being made into local airspace companies, while local and tribal AAM planning entities are having to prioritize their AAM efforts amongst their other funding obligations.

The integration of AAM into a multimodal transportation system is a complicated endeavor involving leveraging existing infrastructure, working with existing and new stakeholders in an evolving regulatory environment. The purpose of this SBIR is to energize an industry around supporting the local community AAM planning efforts while recognizing that these local communities may not have the resources to conduct the planning needed to enable AAM at UAM maturity level-4 (UML-4) on the timeline desired by the entities in the other two pillars. Activities proposed by companies desiring to enter this market shall fill a gap in the communities' current planning efforts.

Three areas of near-term community need have surfaced from NASA conversations with state and city departments of transportation. These include (1) meeting AAM educational and outreach needs, (2) support for planning demonstrations, and (3) AAM system planning.

Educational. A clear and pressing need for education of both local decision makers and the local flying and nonflying public has been identified. The goal of companies proposing to this Small Business Innovation Research (SBIR) would be to enable a robust and cost-conscious capability available to local decision makers to support
them effectively providing a broad range of materials at various levels of detail for their use when engaging entities such as local city councils, mayors, planning boards, and infrastructure planning teams. The company would also be able to provide materials and be able to support organizations that directly engage with and inform the public such as Metropolitan Planning Organizations (MPOs), science museums, and Science, Technology, Education, and Mathematics (STEM)-focused organizations. The company should also be capable of providing materials and outreach capabilities not readily available to these organizations, such as locally targeted virtual reality simulations of AAM operations. The company should also have a detailed and sustained familiarity with the local or state culture, nuances, customs, and values to be able to provide a long-term resource to these planning officials and to be able to craft outreach materials that connect citizens with information and in ways relevant to their local situation. Phase I would be to begin executing the plan in the proposal and developing the materials described as part of the plan. Ideally, the plan would include an initial target local partner (customer). Phase I would also include identifying and contacting a regional or statewide customer base. Phase II would be to provide services to these regional or statewide customers and cementing relationships and a sustainable business.

AAM Demonstrations: Conducting AAM demonstrations is a complicated and involved process that could be markedly easier with expertise associated with having experience and the federal relationships in conducting previous demonstrations. This SBIR would be focused on maturing a company’s capability to support local decision makers in the planning and execution of local AAM demonstrations. These demonstrations would ideally be focused on public-good missions. The capability should include development and analysis of use case(s) or compelling missions, identification and forming the stakeholders needed to execute a demonstration into an effective team, the capability to develop and execute the local outreach necessary for a successful demonstration, knowledge of the local and federal regulations and decision makers critical for the successful execution of the demonstration, and the development and execution of a demonstration that achieves the desired goals whether they are a one-time demonstration or to enable a sustainable capability. Phase I would be to develop a generic plan that can be tailored for each demonstration customer and to compile case studies from previous AAM case studies that would provide lessons learned for future demonstrations and be available for incorporation into the generic plan. Phase I would also identify several localities seeking to conduct or already planning demonstrations. Phase II would be to support a certain number of these efforts in whichever stage they are currently in. Phase II would also include providing overviews to other localities interested in conducting demonstrations with the goal of beginning to build a sustainable customer base.

AAM System Planning Support: Planning for an urban, regional, or statewide passenger or large cargo carrying AAM system is a significantly complicated endeavor. It includes possessing the relevant subject matter expertise, the ability to conduct economic and demand analysis, system modeling and trade analysis, and to be able to provide decision makers either the tools to make those decisions or the material necessary to support the decision-making process. An AAM system could be a system of urban vertiports or a statewide system leveraging existing general aviation airports supplemented by new vertiports. This planning capability is not expected to be a short-term endeavor but could potentially span multiple years from the development of a plan, through its initial construction and updating planning assumptions and analysis as the system matures. The purpose of this SBIR is to create and support the development of companies focused and able to provide long-term, local AAM planning support. A locally focused and long-term strategy would enable the building of long-term partnerships and relationships with local stakeholders including academic entities, business groups, and local and regional planning officials along with an awareness of and appreciation for local culture, customs, and values. Phase I of this SBIR would be to plan the structure needed, obtain the expertise, and identify the data sources needed to conduct AAM system planning for the locality identified in the proposal. Phase II would be to begin to support the locally needed long-term planning efforts.

Proposers seeking funding for aircraft design and individual aircraft operations should submit to vehicle technology subtopic in A1 and proposers seeking airspace design and operations funding should submit to A3 subtopics.

Expected TRL or TRL Range at completion of the Project

1 to 6

Primary Technology Taxonomy

Level 1
Desired Deliverables of Phase I and Phase II

- Analysis
- Prototype
- Hardware
- Software

Desired Deliverables Description

Deliverables are further detailed in each scope.

Phase I Deliverables would include development of initial materials to support (1) meeting AAM educational and outreach needs, (2) support for planning demonstrations, and (3) AAM system planning. Phase I would also include identifying and making contact with a regional or statewide customer base.

Phase II would be to provide services to these regional or statewide customers for education, demonstration planning, or AAM system planning as applicable.

State of the Art and Critical Gaps

Current transportation planning is focused on either airport-based aviation or ground transportation. There are few resources for AAM planning and planning for AAM to be integrated into these modes of transportation. There is a dearth of small businesses that can bring deep local knowledge and the potential for long-term relationships to these communities. These 3 areas have been identified as near-term critical gaps as part of the partnership with 5 departments of transportation. The timing is also ideal to get these companies up and running as demonstrations are currently being planned and executed and the first electric vertical takeoff and landing (eVTOL) aircraft are expected to be certified in 2024.

Relevance / Science Traceability

This subtopic is relevant to the Aeronautics Research Mission Directorate (ARMD) AAM Mission and the 8 projects supporting that mission.

References

- NASAâ€”National Aeronautics Committee briefings: https://www.nasa.gov/aeroresearch/aero-nac-committee
- https://www.nasa.gov/aeroresearch/one-word-change-expands-nasas-vision-for-future-airspace/
- UAM UML-4 ConOps: https://sti.nasa.gov/
- FAA UAM ConOps 1.0: https://nari.arc.nasa.gov/sites/default/files/attachments/UAM_ConOps_v1.0.pdf
Reconfigurable Vertiport Surface Marking

Scope Description

AAMÂ is a concept for safe, sustainable, affordable, and accessible aviation for transformational local and
intraregional missions. AAM includes many potential mission types (e.g., passenger transport, aerial work, and
cargo transport) that may be accomplished with many different aircraft types (e.g., manned, and unmanned;
conventional, short, and/or vertical takeoff and landing; all electric and hybrid electric; etc.) and are envisioned to
bring aviation into people's daily lives. Although passenger-carrying urban air mobility (UAM) is an
AAM mission with much investment, other AAM missions, including but not limited to thin
haul\(\text{\#128;\#153;}\) regional air mobility, small package delivery, and medical transport, are also of interest.
Responses to this subtopic are not limited to strictly any single AAM mission.

AAM at UAM maturity level-4 (UML-4) envisions multiple vehicle types utilizing multiple vertiports variously
configured from one to multiple landing pads.Â It is also envisioned that these vehicle types will mature as more
experience is gained to achieve safety and performance improvements.Â Additionally, the Federal Aviation
Administration (FAA) is currently working on the design advisory circular for these vehicles, and while the planned
2022 engineering brief will meet early needs, definitive design guidance is likely several years away.Â These and
many more factors will impact the markings on vertiport surfaces. While airports are well served by fixed pavement
markings, future vertiports could achieve the needed degree of flexibility with reconfigurable Touchdown and Lift
Off (TLOF) and Final Approach and Takeoff (FATO) areas markings.Â Reconfigurable surface markings could also
serve to assist with the control of embarking and debarking passengers.

Expected TRL or TRL Range at completion of the Project

1 to 3

Primary Technology Taxonomy

Level 1

TX 12 Materials, Structures, Mechanical Systems, and Manufacturing

Level 2

TX 12.X Other Manufacturing, Materials, and Structures

Desired Deliverables of Phase I and Phase II

- Â ResearchÂ
- Â AnalysisÂ
- Â Prototype

Desired Deliverables Description

Phase I of this Small Business Innovation Research (SBIR) would be to design a vertiport surface meeting current
surface performance criterion that also incorporates reconfigurable markings.Â Phase II of this effort would be to
manufacture and demonstrate this surface and begin the process to obtain FAA approval for utilization at future
vertiports.

State of the Art and Critical Gaps

Currently surface markings at airports and heliportsÂ are painted on the surfaceÂ and not reconfigurable without
significant effort.Â Vertiports capable of servicing passengersÂ do not currently exist in the U.S. as design criteria
does not exist and no electric vertical takeoff and landing (eVTOL) have been certified.Â

Relevance / Science Traceability
With the issuance of the FAA’s vertiport design advisory circular not expected until 2025, many entities are hesitant to invest significant resources in infrastructure that has the potential to not meet future standards, requirements, or regulations. The ability to have a vertiport surface that is reconfigurable would reduce the risk for vertiport surfaces to not meet future standards, requirements, or regulations; increase safety; allow vertiport configurations that are specific to a vehicle type; and reduce the cost associated with reconfiguring markings to meet future updated standards, requirements, or regulations.

References

- FAA Airport Technology Research & Development Branch Home Page: https://www.airporttech.tc.faa.gov/Airport-R-D

Scope Title

Low-Altitude Meteorological Information Supplemental Data Service

Scope Description

Currently low-level AAM operations operate either under visual line of sight or under a waiver for beyond visual line of sight (BVLOS). Frequently, if local, approved weather stations, e.g., at an airport located a distance from the operations, reports instrument meteorological conditions (IMC), the entire area is assumed to be under IMC for BVLOS flights. Often, the planned route or area of AAM operations is under visual flight rules (VFR) conditions even though the weather station is reporting IMC or critical weather conditions. The use of data from not currently aviation-approved sensors to identify current local conditions that can be correlated to the data from the selected weather sensor could determine conditions when the certified weather sensor is reporting IMC and the intended area or route of flight is under VFR conditions. For example, the weather at Monterey Bay Regional Airport in California is 0 vertical feet and 0 mi horizontally with no wind and an operator wishes to fly a cargo delivery from Carmel Valley where they can see at least 1,000 ft and 3 mi and their weather station says winds are 5 to 7 kn at a customer in Big Sur, where the customer verifies that the weather is also 1,000 ft and 3 mi with similar winds. The weather between the Valley and Big Sur is not serviced by an approved aviation weather station, but several traffic cameras along the proposed route show the tops of local buildings, images of buildings 3 mi in the distance, and the local vegetation relatively motionless. The operator could utilize this information to determine if the weather-based risk to the flight is acceptable and within the limits of their operating waiver and perform the mission. In a second similar case where the winds at the regional airport were 15 kn and the traffic cameras show local vegetation moving significantly, the operator could then determine that the winds along the route could exceed the operating limits of the aircraft and determine that the risk is too high and not perform the mission. This effort would determine that there is not a high degree of correlation of visibility between the airport and the local surrounding areas but that there was a high degree of correlation between the winds at the airport and those in the surrounding area.

Another potential scenario is around winds aloft. It could be feasible to deploy enough wind lidars to determine with a high degree of accuracy the winds aloft all along a specific route. An effort under this Small Business Innovation Research (SBIR) scope would be to correlate winds speeds aloft with ground windspeeds. This would allow for the deployment of expensive wind lidars and other sensing equipment during initial installation of weather sensing networks to be gradually replaced with less expensive sensors that could utilize this information to provide aloft wind speed information that could be validated at specific points by airborne traffic instead of continuing to maintain an expensive sensing network. It would also identify situations where correlations start to break down or are not possible, for example, around a thunderstorm.
Given the highly localized nature of this effort, it is anticipated that to be effectively commercialized, the location for the research would need to be in conjunction with either current small unmanned aerial system (sUAS) operations or a passenger/large cargo carrying AAM demonstration/planned early operation that would have a high likelihood of potential customers for the capability/data.

**Expected TRL or TRL Range at completion of the Project**

1 to 3

**Primary Technology Taxonomy**

**Level 1**

TX 11 Software, Modeling, Simulation, and Information Processing

**Level 2**

TX 11.4 Information Processing

** Desired Deliverables of Phase I and Phase II**

- Research
- Analysis
- Prototype
- Software
- Hardware

**Desired Deliverables Description**

Phase I will deliver a plan to identify selected reference stations (weather or other sensors, e.g., camera) with accessible access to past and present data, potential low-level routes or areas either being used or planned for early AAM operations (sUAS or vehicles sized to carry passengers), and obtain past reports or plan to develop a collection of adverse weather conditions that can be correlated to topography or pilot reports in the vicinity of the reference stations, low-level routes, and areas. The plan should also outline the methodology to be more fully developed during Phase II and identify opportunities to conduct Phase II investigations in multiple localities.

Phase II would be to collect the data identified in Phase I, refine and execute the methodology outlined in Phase I, and implement that methodology to evaluate whether the conditions along the routes/within the areas satisfy VFR or other conditions when the reference stations are reporting IMC or other conditions.

**State of the Art and Critical Gaps**

Currently there are a limited number of sensors beyond airports that are able to provide actual weather conditions to aircraft flying in the areas envisioned by AAM operations. Installing infrastructure of equal capabilities across the entire U.S. would be prohibitively expensive. This supplemental service would serve to leverage the existing sensors in combination with data correlated from past observations to be able to predict specified routes or areas are accessible to low-level flight when heights of cloud bases at selected reference stations reach specified values. For the winds aloft case, they are currently measured by balloons or onboard aircraft sensors. This results in few, specific point measurements versus a broader data set that would support denser operations.

**Relevance / Science Traceability**

Current sUAS operations are largely using risk-based methodologies to determine whether their vehicles can safely fly in weather conditions provided by a limited number of sensors. This effort would provide a methodology that would provide additional data to inform these risk-based decisions.

**References**
Scope Title

Multipurpose AAM Sensor Networks

Scope Description

AAM is a concept for safe, sustainable, affordable, and accessible aviation for transformational local and intraregional missions. AAM includes many potential mission types (e.g., passenger transport, aerial work, and cargo transport) that may be accomplished with many different aircraft types (e.g., manned and unmanned; conventional, short, and/or vertical takeoff and landing; all electric and hybrid electric; etc.) and are envisioned to bring aviation into people's daily lives. Although passenger-carrying urban air mobility (UAM) is an AAM mission with much investment, other AAM missions, including but not limited to thin haul and regional air mobility, small package delivery, and medical transport, are also of interest. Responses to this subtopic are not limited to strictly any single AAM mission.

At UAM maturity level-4 (UML-4), it is envisioned there will be multiple sensor types networked to perform the functions necessary for safe and efficient movement of passengers and cargo. These networks include sensors for navigation, surveillance, and weather. Types of sensors will include radars, lidars, anemometers, thermometers, and the novel use of sensors such as traffic cameras. Independent sensors could be purchased, installed, and networked to satisfy each need, however, this would be inefficient and expensive. Localities are also investing funds in installing significant networks for both citizen internet connectivity and other efforts such as connected vehicles. This effort is to identify the opportunities and drawbacks associated with multipurpose usage of sensors and networks.

Expected TRL or TRL Range at completion of the Project

1 to 3

Primary Technology Taxonomy

Level 1

TX 08 Sensors and Instruments

Level 2

TX 08.X Other Sensors and Instruments

Desired Deliverables of Phase I and Phase II

• Research
• Analysis
• Prototype
• Software

Desired Deliverables Description

Effort under Phase I of this Small Business Innovation Research (SBIR) would be to collect or catalog performance requirements and capabilities for navigation, surveillance, weather, and other sensors that could potentially perform multiple functions. The effort would also catalog the existing or planned networks supporting these sensors. This would include the use of radars for both aircraft surveillance and precipitation or lidars to determine navigational performance or wind turbulence. Exploration of novel sensors would include the identification of sensors supporting other uses that could benefit AAM operations such as traffic cameras for determining visibility...
and sensors supporting other forms of transportation such as Advanced Road Weather Information System (ARWIS) to provide temperature and potential surface icing conditions. Phase I would also identify sensors existing or being planned for near-term installation that could be leveraged for future demonstrations.

Phase II of this effort would be to leverage existing AAM activities to investigate the potential incorporation of additional AAM functionality while utilizing current or planned sensors. Potential activities could include the Ohio Department of Transportation (DOT)’s Route 33 Active Traffic Management (ATM) efforts, Minnesota’s extensive ARWIS system, or North Central Texas Collaborative Adaptive Sensing of Atmosphere (CASA), or it’s Arlington Entertainment district demonstration. Efforts in Phase II would also identify potential additional benefits achievable through these sensors such as counter drone capability or weather warning alerting to the local community.

State of the Art and Critical Gaps

Current state of the art is to identify and utilize either customized or purpose built sensors targeted to meet the requirements for the system they are supporting. While this results in high performance capability, these networks are both expensive to install and maintain and difficult to upgrade with new and innovative technologies and capabilities. This SBIR would be a start at closing the gap between attempting to fund expensive single purpose systems and installing affordable capable systems with shorter return on investments and more amenable to upgrading.

Relevance / Science Traceability

Information collected during this phase should also be targeted to inform the ATM-X AAM X series simulations and potential automated vertiport functions being investigated by the High Density Vertiport subproject within the AAM Project.

References