NASA SBIR 2022 Phase I Solicitation

A3.04 Nontraditional Airspace Operations and Aerial Wildfire Response

Lead Center: ARC

Participating Center(s): LaRC

Scope Title
Nontraditional Airspace Operations

Scope Description
NASA is exploring airspace operations incorporating unmanned vehicles and novel operations occurring in all airspaces (controlled and uncontrolled), with a goal to safely and efficiently integrate with existing operations and mission types. NASA’s research to enable unmanned vehicles to be safely and fully integrated into existing airspace structures (or lack thereof) has already demonstrated the potential benefits and capabilities of a service-based architecture (such as that developed for the Unmanned Aircraft Systems Traffic Management (UTM) Research and Development (R&D) evaluations), and has led to new procedures, equipage and operating requirements, and policy recommendations, to enable widespread, harmonized, and equitable execution of diverse unmanned missions.

This scope is focused on Urban Air Mobility (UAM)/Advanced Air Mobility (AAM) airspace operations only and is not accepting proposals specific to other nontraditional operations. In addition, proposals that focus only on cyber-resiliency solutions without proposing specific UAM/AAM services, will be declined.

This subtopic seeks proposals to continue to adapt the UTM concept elements for application to UAM/AAM including:

- Service-based architecture designs that enable dense and/or increasingly complex UAM operations.
- Dynamic route planning that considers changing environmental conditions, vehicle performance and endurance, and airspace congestion and traffic avoidance.
- Dynamic scheduling for on-demand access to constrained resources and interaction between vehicles with starkly different performance and control characteristics.
- Integration of emergent users with legacy users, large commercial transport, including pass-through to and from ultrahigh altitudes and interactions around major airports.
- Operational concepts for fleet and network management, market need and growth potential for future operations, and airspace integration.
- Identification of potential certification approaches for new vehicles operations (such as electric vertical takeoff and landing).
Future service-based architectures also require resiliency to cyberattacks to ensure safe and robust operations that maintain expected levels of safety, as well as accommodating changes to environmental and operational conditions. Therefore, proposals should incorporate cyber-resiliency methods, tools, or capabilities, or address cyber-resiliency as part of the proposed effort, but proposals focused exclusively on cybersecurity will be declined.

Expected TRL or TRL Range at completion of the Project:

1 to 4

Primary Technology Taxonomy:
Level 1: TX 16 Air Traffic Management and Range Tracking Systems
Level 2: TX 16.3 Traffic Management Concepts

Desired Deliverables of Phase I and Phase II:
- Research
- Analysis
- Prototype
- Software

Desired Deliverables Description:
Technologies that can advance safe and efficient growth in global operations (Aeronautics Research Mission Directorate (ARMD) Thrust 1 Goal) as well as developing autonomy applications for aviation (as under ARMD Thrust 6), that are specifically applicable to UAM operations, and address post-pandemic recovery, as appropriate.

Phase I deliverables may take the form of a prototype/proof-of-concept decision support tool, automation and/or service, a proof-of-concept demonstration of the underlying architecture, and/or validation of the approach taken, which shows focus on a particular aspect or use case of the R&D challenge being investigated.

Phase II deliverables would presumably take the form of higher TRL tools/decision support services that convincingly demonstrate a solution to the proposed R&D challenge.

State of the Art and Critical Gaps:
Current state of the art - Nontraditional airspace operations: NASA has been researching advanced air transportation concepts and technologies to improve commercial operations in the National Airspace System and has been applying this expertise, as well as a service-based architecture and concepts pioneered for UTM, towards UAM/AAM.

Critical gaps - Nontraditional airspace operations: Significant challenges remain to fully develop the UAM/AAM airspace concept of operations, including integrating air transportation technologies across different domains and operators; providing comprehensive, strategic scheduling and traffic management technologies; and enabling concepts that will allow for scaling demand and complexity of operations. This subtopic is focused on the Airspace Operations of the UAM/AAM concept only. Proposals must have clear application to UAM/AAM airspace operations. Proposals that focus on UAM/AAM vehicle capabilities, or onboard vehicle technologies or systems, will be declined. Proposals that are specific to other nontraditional operations (such as, but not limited to, space traffic management, automated air cargo, UTM, and ultrahigh altitude), without clear application to UAM/AAM, will be declined.

Relevance / Science Traceability:
Airspace Operations and Safety Program (AOSP).
Air Traffic Management-eXploration (ATM-X) Project.
Successful technologies in this subtopic will help NASA pioneer UAM concepts and technologies. The technologies also incorporate new autonomy/artificial intelligence/data science methods and approaches to air transportation problems for current and near-future application.

References:

2. NASA Ames Aviation Systems Division publications: https://aviationsystems.arc.nasa.gov/publications/index.shtml
3. NASA Ames Aviation Systems Division: https://aviationsystems.arc.nasa.gov/index.shtml
4. ARMD Strategic Implementation Plan: https://www.nasa.gov/aeroresearch/strategy

Scope Title

Aviation Operations for Wildfire Response

Scope Description

In the United States, wildfires are becoming increasingly severe and costly in terms of acreage burned, property damage, and most importantly, lives lost. Wildfire frequency and intensity is escalating, inducing budgetary, personnel, and equipment challenges. Furthermore, California and other western states have been facing persistent drought conditions and much hotter temperatures, which are fueling wildfire intensity and duration. These alarming trends have made it urgent to recognize how wildfires could be better predicted, mitigated, and managed.

NASA has a history of contributions to wildfire and other disaster management including remote sensing, instrumentation, mapping, data fusion, and prediction. More recently, the NASA Aeronautics Research Mission Directorate (ARMD) has been investigating capabilities to help manage wildfire suppression and mitigation efforts through technologies for coordination of airspace operations for wildfire management.

NASA ARMD has recently made significant contribution to enable widespread use of small unmanned aircraft systems (sUAS) by developing air traffic management capabilities for low-altitude unmanned vehicle operations, called UAS Traffic Management (UTM). This work is being expanded to safely and efficiently integrate larger Urban Air Mobility (UAM) vehicles and operations with existing operations and mission types. NASA recognizes the value these capabilities could provide when applied to the aerial wildfire management domain.

Current applications of aviation to wildfire management include deployment of smokejumpers to a fire, transport of firefighters, equipment and supplies, fire retardant or water drop, reconnaissance of fire locations and fire behavior, and supervision of air tactical operations.

Current challenges of aerial wildfire management include: existing airspace management techniques are manual and cannot accommodate the demand for new types of aircraft (e.g., unmanned aircraft); aerial firefighting is limited to acceptable visual conditions (no night operations); monitoring and remote sensing missions are intermittent, flown outside of active fire-fighting or available periodically from satellite assets; and there is a lack of reliable, resilient, and secure data communications for quick information dissemination to support effective decision making.

NASA is seeking technologies to:

- Provide an extension to the UTM network considering the unique needs and characteristics of wildfire disaster situations and the response to combat them.
- Provide capabilities that address UAS integration to aerial wildfire management but also have the potential to represent a dynamic airspace for coordination of multiple manned and unmanned vehicles.
- Increase the capacity of available communications, reduce the latency of data transfer, and provide a persistent network for the use of UAS and other aviation assets by emergency responders.
- Provide airspace coordination and resource tracking for a common operating picture for situational awareness.
Ensure highest safety and efficiency of operations.

Expected TRL or TRL Range at completion of the Project:

1 to 5

Primary Technology Taxonomy:
Level 1: TX 16 Air Traffic Management and Range Tracking Systems
Level 2: TX 16.3 Traffic Management Concepts

Desired Deliverables of Phase I and Phase II:

- Research
- Analysis
- Prototype
- Software

Desired Deliverables Description:

Phase I deliverables may include prototype/proof-of-concept decision support tool, automation and/or service, a proof-of-concept demonstration of the underlying architecture, and/or validation of the approach taken, which shows focus on a particular aspect or use case of the research and development challenge being investigated.

Phase II deliverables would presumably take the form of higher TRL tools/decision support services that convincingly demonstrate a solution to the proposed research and development challenge.

State of the Art and Critical Gaps:

The current state of the art for coordination of aerial firefighting is a manual process that must be coordinated across multiple entities, often bringing multiple aerial assets to wildfire fighting environment. Advanced tools and techniques are required to address the following gaps:

- Existing airspace management process very manual and slow.
- Awareness of aircraft operations conducted by visual monitoring and radio communication.
- Unmanned systems are not easily integrated into aerial fire suppression operations.
- Operations are limited by visibility and no operations are conducted at night when fires often die back.
- Surveillance images are captured and disseminated only every 4 hours.
- Intermittent communication can delay effective response.
- Conditions can rapidly change requiring timely information for effective decision making.
- Decision makers for emergency response are overloaded with data.
- Information requirements differ for various roles within the disaster response.

Tools and data are often spread across numerous applications.

Relevance / Science Traceability:

Due to climate change, wildfires are becoming increasingly more frequent and severe. Fire seasons are longer, lasting 6 to 8 months and in some cases are year-round. The 2020 fire season was the worst in recorded history, burning over 4 million acres of land, destroying more than 8,500 structures, and killing more than 30 people. The economic impact of these fires is in the hundreds of billions of dollars and results in lasting societal impact. The annual cost of fire suppression has soared from roughly $425 million per year in 1999 to $1.6 billion in 2019.
Recently, President Biden and Vice President Harris met with Governors from western states, Cabinet officials, and private sector partners to discuss specific actions the public and private sector are each taking to strengthen prevention, preparedness, mitigation, and response efforts to protect communities across our country from wildfires and their devastating impacts. The President directed a number of actions, in close coordination with State and local governments and the private sector, to ensure the Federal Government can most effectively protect public safety and deliver assistance to our people in times of urgent need.

References:

2. NASA Ames Aviation Systems Division publications: https://aviationsystems.arc.nasa.gov/publications/index.shtml
3. NASA Ames Aviation Systems Division: https://aviationsystems.arc.nasa.gov/index.shtml
4. ARMD Strategic Implementation Plan: https://www.nasa.gov/aeroresearch/strategy