NASA SBIR 2019 Phase I Solicitation

A3.03 Future Aviation Systems Safety

Lead Center: ARC

Participating Center(s): LaRC

Technology Area: TA15 Aeronautics

Public benefits derived from continued growth in the transport of passengers and cargo are dependent on the improvement of the intrinsic safety attributes of the Nation's and the world's current and future air transportation system. Recent developments to address increasing demand are leading to greater system complexity, including airspace systems with tightly coupled air and ground functions as well as widely distributed and integrated aircraft systems. Current methods of ensuring that designs meet desired safety levels will likely not scale to these levels of complexity (Aeronautics R&D Plan, p. 30). The Airspace Operations and Safety Program (AOSP) is addressing this challenge with a major area of focus on In-time System-wide Safety Assurance (ISSA). A proactive approach to managing system safety requires two abilities:

- The ability to monitor the system continuously and to extract and fuse information from diverse data sources (while identifying emergent anomalous behaviors after new technologies, procedures, and training are introduced).
- The ability to reliably predict probabilities of the occurrence of hazardous events and of their safety risks.

Understanding and predicting system-wide safety concerns of the airspace system and the vehicles as envisioned by the Next Generation Air Transportation System (NextGen) and beyond is paramount. Such a system would include the emergent effects of increased use of automation and autonomy to enhance system capabilities, efficiency, and performance beyond current capability of human-based systems. These systems would advance technology through health monitoring of the system-wide functions that are integrated across distributed ground, air, and space systems. Emerging highly autonomous operations such as those envisioned for Unmanned Aerial Systems (UAS) and Urban Air Mobility (UAM) will play a major role in future airspace systems. In particular operating Beyond the operator's Visual Line-Of-Sight (BVLOS) and near or over populated areas are topics of concern. Safety-critical risks include:

- Flight outside of approved airspace.
- Unsafe proximity to people/property.
- Critical system failure (including loss of C2 link, loss or degraded GPS, loss of power, and engine failure).
- Loss-of-control (i.e., outside the envelope or flight control system failure).

Tools are being sought for use in creating prototypes of ISSA capabilities. The ultimate vision for ISSA is the delivery of a progression of capabilities that accelerate the detection, prognosis, and resolution of system-wide threats.

Proposals under this subtopic are sought, but are not limited to, development and/or demonstration in the following areas (with an emphasis on safety applications):

- Data collection architecture, data exchange model, and data collection mechanism (for example, via UAS Traffic Management (UTM) Technical Capability Level 4 (TCL-4)).
- Data mining tools and techniques to detect and identify anomalies and precursors to safety threats system-wide.
- Tools and techniques to assess and predict safety margins system-wide to ensure airspace safety.
- Prognostic decision support tools and techniques capable of supporting in-time safety assurance.
- Verification and Validation (V&V) tools and techniques for ensuring the safety of air traffic applications during certification and throughout their lifecycles as well as techniques for supporting the in-time monitoring of safety requirements during operation.
- Products to address technologies, simulation capabilities, and procedures for reducing flight risk in areas of attitude and energy aircraft state awareness.
- Decision support tools and automation that will reduce safety risks on the airport surface for normal operations and during severe weather events.
- Alerting strategies/protocols/techniques that consider operational context as well as operator state, traits, and intent.
- Methodologies and tools for integrated prevention, mitigation, and recovery plans with information uncertainty and system dynamics in a UAS and in a Trajectory-Based Operations (TBO) environment.
- Strategies for optimal human-machine coordination for in-time hazard mitigation.
- Methods and technologies enabling transition from a dedicated pilot-in-command or operator for each aircraft (as required per current regulations) to single operators safely and efficiently managing multiple unmanned and UAM aircraft in civil operations.
- Measurement methods and metrics for human-machine team performance and mitigation resolution.
- System-level performance models and metrics that include interdependencies and relationships among human and machine system elements.

Expected TRL for this project is 1 to 3.

Relevance to NASA

This technology is applicable to the Airspace Operations and Safety Program (AOSP).

References:

https://www.nasa.gov/aeroresearch/programs/aosp