



NASA SBIR 2011 Phase I Solicitation

A3 Airspace Systems

NASA's Airspace Systems Program (ASP) is investing in the development, validation and transfer of advanced innovative concepts, technologies and procedures to support the development of the Next Generation Air Transportation System (NextGen). This investment includes partnerships with other government agencies represented in the Joint Planning and Development Office (JPDO), including the Federal Aviation Administration (FAA) and joint activities with the U.S. aeronautics industry and academia. As such, ASP will develop and demonstrate future concepts, capabilities, and technologies that will enable major increases in air traffic management effectiveness, flexibility, and efficiency, while maintaining safety, to meet capacity and mobility requirements of NextGen. ASP integrates the two projects NextGen Concepts and Technology Development (CTD) and NextGen Systems Analysis Integration and Evaluation (SAIE), to directly address the fundamental research needs of NextGen vision in partnership with the member agencies of the JPDO. The CTD develops and explores fundamental concepts, algorithms, and air-borne and ground-based technologies to increase capacity and throughput of the national airspace system, to address demand-capacity imbalances, and achieve high efficiency in the use of resources such as airports, en route and terminal airspace. The SAIE Project is responsible for facilitating the Research and Development maturation of integrated concepts through evaluation in relevant environments, providing integrated solutions, characterizing airspace system problem spaces, defining innovative approaches, and assessing the potential system impacts and design ramifications of the program's portfolio. Together, the projects will also focus NASA's technical expertise and world-class facilities to address the question of where, when, how and the extent to which automation can be applied to moving air traffic safely and efficiently through the NAS and technologies that address optimal allocation of ground and air technologies necessary for NextGen. Additionally, the roles and responsibilities of humans and automation influence in the ATM will be addressed by both projects. Key objectives of NASA's AS Program are to:

- Improve mobility, capacity, efficiency and access of the airspace system.
- Improve collaboration, predictability, and flexibility for the airspace users.
- Enable accurate modeling and simulation of air transportation systems.
- Accommodate operations of all classes of aircraft.
- Maintain system safety and environmental protection.

Subtopics

A3.01 Concepts and Technology Development (CTD)

Lead Center: ARC

Participating Center(s): AFRC, LaRC

The Concepts and Technology Development (CTD) Project supports NASA Airspace Systems Program objectives by developing gate-to-gate concepts and technologies intended to enable significant increases in the capacity and efficiency of the Next Generation Air Transportation System (NextGen), as defined by the Joint Planning and Development Office (JPDO).

The CTD project develops and explores fundamental concepts, algorithms, and technologies to increase throughput of the National Airspace System (NAS) and achieve high efficiency in the use of resources such as airports, en route and terminal airspace. The CTD research is concerned with conducting algorithm development, analyses and fast-time simulations, identifying and defining infrastructure requirements, field test requirements, and conducting field tests.

Innovative and technically feasible approaches are sought to advance technologies in research areas relevant to NASA's CTD effort. The general areas of primary interest are:

Traffic Flow Management

- Flow management to mitigate large-scale climate disruptions, such as volcanic ash, or other natural disaster phenomena.

Super Density Operations

- Environmental and traffic efficiency metrics and assessments to compare different super-density operations concepts and technologies.
- Application of environmental and traffic efficiency metrics specifically for congested airspace or mixed equipage scenarios.
- Cost-effective integration of advanced speed control capabilities into the cockpit to enable environmentally friendly super density operations.

Separation Assurance

- Develop and demonstrate a prototype capability to output real-time schedules (e.g., from Traffic Management Advisor) from current operational en route computers (e.g., ERAM and/or Host) to an external system to support trajectory-based operations research and simulation.

Trajectory Design

- Trajectory design and conformance monitoring for surface, terminal area, and en route.
- Trajectory implementation/execution in flight deck automation and automated air traffic control.
- Innovative methods to improve individual aircraft (surface, climb, descent and cruise) trajectories and air traffic operations to reduce the environmental impact.

Dynamic Airspace Configuration

- Flexible/adaptable airspace boundaries for NextGen operations in both en route and terminal airspace.
- Generic-airspace operations, including airspace design attributes and human factors considerations such as procedures and decision support tools.
- Tubes-in-the-sky operational concept development, including air/ground equipment requirements and design of a dynamic tube network.
- Dynamic airspace allocation to facilitate operations of UAVs and/or commercial space vehicles in the national airspace system .

Human Factors

- Design considerations for Tower/surface controller tools.
- Graphical user-interface systems for air traffic management/flight deck and ground-based automation simulation and testing applications.

Weather

- Common situational awareness between flight deck and ground automation systems for weather avoidance (may be related to 4D weather cube)
- Integrating weather products into decision support tools
- Airspace capacity estimation in presence of weather
- Means for creating realistic, consistent 3-D weather objects/imagery across numerous automation systems (e.g., a flight simulator out-the-window scene, cockpit radar display, airline operations weather display, ground radar image of the same weather object).

Atmospheric Hazards

- Development of wake vortex detection and hazard metric tools.

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- Wake modeling and sensing capabilities implemented into the flight deck for airborne aircraft separation and spacing.
 - Development of enroute wake turbulence identification and mitigation tools, processes, and systems.
 - Novel, compact, and field-deployable laser remote sensing technologies for measuring meteorological parameters (e.g., wind, temperature, pressure, and turbulence) at ranges >1km in support of characterization of aircraft generated wake vortices.

Methods and Methodologies

- Algorithms and methods to satisfy multi-criteria design needs in air traffic management.
- Integrated hardware/software tool for accelerating general optimization tasks.
- Applying novel computing concepts to ATM problems.
- Experimental methodology, including scenario development, for incorporating rare events in realistic and dynamic human-in-the-loop air traffic management research, and methods for analyzing cause and effect in post experiment data.
- Stand-alone graphical user interface capabilities for data collection and processing of meteorological remote sensing technologies.

Other

- Derived sensor information from both ground-based radar trackers and ADS-B information for derivation of airspeed and local wind information.

A3.02 Systems Analysis Integration Evaluation (SAIE)

Lead Center: LaRC

Participating Center(s): AFRC, ARC

SAIE will provide systems level analysis of the NAS characteristics, constraints, and demands such that a suite of capacity-increasing concepts and technologies for system solutions are enabled and facilitated, integrated, evaluated and demonstrated. SAIE is responsible for characterizing airspace system problem spaces, defining innovative approaches, assessing the potential system-level benefits, impacts and safety.

Specific innovative research topics being sought by SAIE include:

Airspace System Level Concepts Development

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- NextGen airspace system safety assessment, graceful degradation, fault tolerant, and recovery concepts and methodologies.
 - System level capacity and environmental (e.g., CO₂, NO_x emissions and noise) improvement concepts and assessments and methodologies.
 - System level NextGen assessments, concepts and methodologies that incorporate and/or inform future vehicle and fleet designs.
 - Autonomous and distributed system concepts.
 - Concepts that study system-wide effects of various functional allocations.
 - Revolutionary airspace system concepts, designs and methodologies.

Trajectory Modeling and Uncertainty Prediction

- Analysis of growth of uncertainty as a function of look-ahead time on different phases of flight.
- Development of methods to determine, for a target concept/system, the TP accuracy needed to be able to achieve the minimum acceptable system/concept performance as well as identify sources of errors.
- Development of methods for managing/reducing trajectory uncertainty to meet specified performance requirements.
- Identify critical aircraft behavior data for exchange for interoperability.
- Innovative methods to improve individual aircraft (surface, climb, descent and cruise) trajectories and air traffic operations to reduce the environmental impact.

Roles and Responsibilities in NextGen

- Systems analysis concepts, assessments and methodologies to optimize air-ground and automation functional allocation for NextGen (e.g., functional allocation options between human/machine and among AOC, flight deck and service provider).
- Airspace systems-level concepts, assessments and methodologies using increasing levels of autonomy.

Modeling and Simulation (should be relevant to NASA Airspace Program objectives)

- Develop new methods that help in assessing and designing airspace to improve system level performance (e.g., increase capacity, reduce complexity, optimize or improve performance of the air transportation network architecture).
- Explicit methodologies relevant to applications can include:
 - Rigorous predictive modeling of uncertainty in various parts of the system and its propagation.

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- Multiobjective decision making algorithms for all aspects of decision making and optimization in the system.
 - Model/dimension reduction for improved computational tractability.
 - Methods for managing multiscale phenomena in the NAS.
 - Methods for quantifying and managing complexity and uncertainty.
 - Methods for assessing the necessary balance between predictability and flexibility in the system, especially in the presence of autonomy.