NASA SBIR 2008 Phase I Solicitation

A3 Airspace Systems

NASA's Airspace Systems (AS) Program is investing in the development of innovative concepts and technologies to support the development of the Next Generation Air Transportation System (NGATS is also commonly known as NextGen). NASA is working to develop, validate and transfer advanced concepts, technologies, and procedures through partnership with the Federal Aviation Administration (FAA) and other government agencies represented in the Joint Planning and Development Office (JPDO), and in cooperation with the U.S. aeronautics industry and academia. As such, the AS Program 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. The AS Program integrates the two projects, NextGen Airspace and NextGen Airportal, to directly address the fundamental research needs of NextGen vision in partnership with the member agencies of the JPDO. The NextGen Airspace Project develops and explores fundamental concepts and integrated solutions that address the optimal allocation of ground and air automation technologies necessary for NextGen. The project will 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 aircraft safely and efficiently through the NAS. The NextGen Airportal Project develops and validates algorithms, concepts, and technologies to increase throughput of the runway complex and achieve high efficiency in the use of airportal resources such as gates, taxiways, runways, and final approach airspace. NASA research in this project will lead to development of solutions that safely integrate surface and terminal area air traffic optimization tools and systems with 4-D trajectory operations. Ultimately, 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; and
- Maintain system safety and environmental protection.

Additional information is available at http://www.aeronautics.nasa.gov/programs_asp.htm.

Subtopics

A3.01 NextGen Airspace

Lead Center: ARC

Participating Center(s): AFRC, ARC, LaRC

The primary goal of the NASA Next Generation Air Transportation System (NextGen) Airspace effort is to develop integrated solutions for a safe, efficient, and high-capacity airspace system. Of particular interest is the development of core capabilities, including: (1) Performance-based services, which will enable higher levels of performance in proportion with user equipage level; (2) Trajectory-based operations, which is the basis for changing the way traffic is managed in the system to achieve increases in capacity and efficiency; (3) Super-density operations, which maximizes the use of limited runways at the busiest airports; (4) Weather assimilated into decision making; (5) Equivalent visual operations, which will allow the system to maintain visual flight rule capacities in instrument flight rule conditions. These core capabilities are required to enable key NGATS-Airspace functions such as Dynamic Airspace Configuration, Traffic Flow Management, Separation Assurance, and the overarching Evaluator that integrates these air traffic management (ATM) functions over multiple planning intervals.

In order to meet these challenges, innovative and technically feasible approaches are sought to advance technologies in research areas relevant to NASA's NextGen Airspace effort. The general areas of primary interest are Dynamic Airspace Configuration, Traffic Flow Management, and Separation Assurance. Specific research topics for NextGen Airspace include:

- 4D trajectory based operations;
- Air/ground automation concepts and technologies;
- Airspace modeling and simulation techniques;
- Automated separation assurance;
- Collaborative decision making techniques involving multiple agents;
- Equivalent visual operations;
- "Evaluator" integrated solutions of ATM functions over multiple planning intervals;
- Human factors for ATM;
- Locus of control across humans and automation;
- Multi-aircraft flow and airspace optimization;
- Performance based services;
- Safety analysis methods;
- Spacing and sequencing management;
- Super density terminal area operations;
- Traffic complexity monitoring and prediction;
- Traffic flow management concepts/techniques;
- Trajectory design and conformance;
- Weather assimilated into ATM decision-making.

A3.02 NextGen Airportal

Lead Center: LaRC

Participating Center(s): AFRC, ARC, LaRC

The Airportal research of NASA's Airspace Systems (AS) Program focuses on key capabilities that will increase throughput of the Airportal environment and achieve the highest possible efficiencies in the use of Airportal resources such as terminal airspace, runways, taxiways, and gates. The primary capabilities addressed are: (1) Super-density operations, (2) Equivalent visual operations, (3) Aircraft trajectory-based operations, and (4) Improved understanding of wake vortices.

Super-density operations will include conflict detection and resolution for closely spaced approaches, reduced aircraft wake vortex separation standards, and less restrictive run-way/taxiway operations. Additional mechanisms to increase the feasible density of operations will also be considered.

Equivalent visual operations will provide aircraft with the critical information needed to maintain safe distances from other aircraft during non-visual conditions, including a capability to operate at "visual performance" levels on the airport surface during low-visibility conditions. Advances in equivalent visual operations for the Airportal air navigation service provider are also of interest.

Aircraft trajectory-based operations will utilize 4D trajectories (aircraft path from block-to-block, including path along the ground, and also including the time component) as the basis for planning and executing system operations.

Wake vortices are often the ultimate limitation for many advanced, high-efficiency operational concepts. Advances in sensors, simulations of wake vortices and sensors, weather modeling and measurements, and understanding of impacts to aircraft flight are all of interest.

NASA's AS Program has identified the following Next Generation Air Transportation System (Next Gen) Airportal research activities: optimization of surface aircraft traffic; dynamic airport configuration management (including the optimal balancing of Airportal resources for arrival, departure, and surface aircraft operations); predictive models to enable mitigation of wake vortex hazards; new procedures for performing safe, closely spaced, and converging approaches at closer distances than are currently allowed; modeling, simulation, and experimental validation research focused on single and multiple regional airports (metroplex); and other innovative opportunities for transformational improvements in Airportal/metroplex throughput. Inherent to the AS Program approach is the integration of airborne solutions within the overall surface management optimization scheme.

In order to meet these challenges, innovative and technically feasible approaches are sought to advance technologies in research areas relevant to NASA's Next Gen/Airportal effort. The general areas of interest are surface management optimization, converging and parallel runway operations, safety risk assessment methodologies, and wake vortex solutions inside Metroplex boundaries. Specific research topics for Next Gen/Airportal include:

- Airborne spacing algorithms and wake avoidance procedures for airports with closely spaced runways;
- Algorithms for determining wake vortex encounters from aircraft flight data recorders;
- Automated separation assurance and runway/taxiway incursion prevention algorithms ;
- Automatic taxi clearance and aircraft control technologies;
- Characterization of wake vortex and atmospheric hazards to flight in terms of aircraft and flight crew responses;
- Collaborative decision making between airlines and airport traffic control tower personnel for optimized surface operations, including push back scheduling and management of airport surface assets;
- Development of wake vortex hazard assessment algorithms;
- Dynamic airport configuration management;
- Fusion of data from weather sensors and models for input into weather prediction models;
- High resolution CFD and real-time modeling of wake vortex strength and location;
- Human/automation interaction and performance standards;
- Improved wake vortex circulation estimates derived from Pulsed Lidar;
- Innovations in wake vortex sensors;
- Integration of decision-support tools across different airspace domains;
- Lidar Simulation tools for wake vortices;
- Measurements of wind, temperature, and turbulence from departing and arriving aircraft;
- Methodologies and/or algorithms to estimate environmental impacts of increased traffic on the surface and in the terminal airspace, and to reduce the environmental impacts under increased levels of traffic;
- Methodologies to estimate and assess the risk of transformational airspace operations for which little historical risk data may exist and for which operations may be constrained by the potential for extremely rare events;
- Modeling and simulation of airport operations for validating aircraft taxi planning concepts;
- Optimized 4D aircraft trajectory generation and conformance monitoring for surface and terminal airspace operations, including departure and arrival planning for individual flights;
- Radar simulation tools for wake vortices;
- Radically innovative approaches for detection of wake vortices;
- Scheduling algorithm for aircraft deicing and integration with a surface traffic decision-support tool;
- Surface and terminal airspace traffic modeling and simulation of multiple regional airports;
- Virtual airport traffic control towers;
- Weather sensors for supporting wake vortex predictions;

- Other technologies and approaches to achieving 2-3X improvement in the throughput of Airportal/metroplexes.

Note: The development of technologies for the airborne detection of wake vortices is covered in Subtopic A1.04.