SBIR/STTR
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NASA SBIR 2009 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, LaRC

The primary goal of the Airspace project is to develop integrated solutions for a safe, efficient, and high-capacity airspace system. Of particular interest is the development of core capabilities, including:

- Trajectory-based operations, which manages traffic using 4-dimensional trajectories to achieve increases in capacity and efficiency;
- Super-density operations, which maximizes the use of limited runways at the busiest airports;
- Weather assimilated into decision making, with emphasis on probabilistic weather;
- 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 Airspace project functions such as Dynamic Airspace Configuration, Traffic Flow Management, Separation Assurance, and the overarching Evaluator that integrates these 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 the Airspace project include:

- Four-dimensional trajectory modeling in the presence of uncertainty;
- Air/air and air/ground trajectory exchange interoperability;
- Trajectory uncertainty prediction and mitigation;
- Intent information requirements for separation assurance and super density operations;
- Airspace re-design techniques that improve capacity, including changing shape of current sectors and introducing new airspace classes;
- Pilot and controller procedures and decision support systems needed to facilitate dynamic airspace changes;
- Collaborative decision making techniques involving multiple agents;
- Integrated solutions of ATM functions over multiple planning intervals and across domains;

- Optimal allocation of separation assurance functions across humans and automation and air and ground systems;
- Optimization techniques to address demand/capacity imbalances;
- New safety assessment methods for safety-critical air and ground automation technologies;
- Scheduling optimization for integrated arrival/departure/surface operations;
- Displays and procedures for very closely-spaced parallel approaches;
- Traffic complexity monitoring and prediction;
- Trajectory design and conformance monitoring;
- Weather assimilated into ATM decision-making;
- Environmental metrics and assessments of new concepts and technologies;
- The effect of new vehicles (including UAVs) on air traffic management;
- Gate-to-Gate modeling for NextGen concepts;
- Integration of UAVs into the NAS, including examination of the anticipated mix of UAV classes and capabilities (equipment, size, mission) in the next 20 years;
- The effect of traffic congestion on integration of UAVs into the NAS;
- Separation assurance responsibilities with regard to UAVs;
- The requirements for, and the development of, a simulation environment to test UAV integration in the NAS.

A3.02 NextGen Airportal

Lead Center: LaRC

Participating Center(s): AFRC, ARC

Airportal research focuses on key capabilities that will increase throughput of the airport environment, and that achieve the highest possible efficiencies in the use of airport resources such as terminal airspace, runways, taxiways, and gates. Of particular interest is the development of the following core capabilities within Airportal:

- 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);
- Other innovative opportunities for transformational improvements in Airportal/metroplex throughput.

Inherent to the ASP 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 movement 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:

- Human/automation interface concepts and standards for flight crews and air traffic control personnel specific to surface/airportal operations;
- Integration of decision-support tools across different airspace domains;
- Advanced technologies and approaches to achieving 2-3X improvement in the throughput of airports and metroplexes;
- Automatic taxi clearance and aircraft control technologies;
- Scheduling algorithm for aircraft deicing and integration with a surface traffic decision-support tool;
- 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;
- Real-time assessment of the performance of surface operations;
- Computationally efficient solution methods for surface traffic planning optimization problems;
- Automation concepts and technologies for handling off-nominal situations and failure recovery mechanism;
- Design of computer-human interface (CHI) for ground-based automated surface traffic management;
- 4D taxi clearances and air-ground trajectory negotiation for landing aircraft;
- Innovative concepts, technologies, and procedures for safely increasing throughput of runways, especially combinations of parallel, converging, and intersecting runways;
- Innovative concepts, technologies, and procedures to maintain airport runway throughput under off-nominal conditions such as zero-zero ceiling and visibility;
- Innovative ideas for very closely spaced parallel runway operations, including airborne spacing algorithms and wake vortex avoidance procedures;
- Algorithms for determining wake vortex encounters from aircraft flight data recorders;
- Wake vortex hazard research, especially: establishment of wake vortex encounter hazard threshold,

encounter assessment tools, development of a wake vortex hazard metric, flight crew awareness and response techniques;

- Fusion of data from weather sensors and models for automated input into atmospheric prediction models (e.g., Terminal Area Simulation SystemÃ‚-TASS) used for assessments of atmospheric hazards to aviation and for initializing wake vortex prediction software;
- Innovations in sensors for detection of wake vortices as well as with weather sensors in support of wake vortex predictions;
- Measurements of wind, temperature, and turbulence from departing and arriving aircraft;
- Radar simulation tools for wake vortices.

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