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). The NGATS vision calls for a system-wide transformation leading to a new set of capabilities that will enable the system to respond to future needs of the nation for air transportation. 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. The NGATS concept for 2025 envisions the safe, efficient, reliable, and secure movement of large numbers of people and goods throughout the air transportation system. It is a system founded on an underlying set of operating principles. Central to these principles is the requirement for a system-wide transformation involving change in organization, as well as culture and policy to assure that the system meets the requirements of the user. The NGATS will provide cost-effective services that are responsive to changing user needs. The system will be designed for environmental compatibility and global interoperability. The major technical challenges are to:

- Accommodate projected growth in air traffic while maintaining safety;
- Provide all airspace system users more flexibility and efficiency in their utilization of airports, airspace, and aircraft classes;
- Reduce system delays; and,
- Enable new modes of operation that support the transition to NGATS operations in a continually evolving technical environment.

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.

The AS program integrates two projects: NGATS-Airspace and NGATS-Airportal.

**Subtopics**

**A3.01 Next Generation Air Transportation System - Airspace**

Lead Center: ARC

Participating Center(s): AFRC, LaRC

The primary goal of the NASA Next Generation Air Transportation System (NGATS) 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 NGATS-Airspace effort. The general areas of primary interest are Dynamic Airspace Configuration, Traffic Flow Management, and Separation Assurance. Specific research topics for NGATS-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 Next Generation Air Transportation - Airportal

**Lead Center:** LaRC

**Participating Center(s):** ARC

The airportal research of NASA's Airspace Systems (AS) Program focuses on key capabilities that will increase throughput of an airport runway complex and achieve the highest possible efficiencies in the use of airportal resources such as runways, taxiways, terminal airspace, gates, and aircraft servicing equipment. The primary capabilities addressed are: (1) Super-density operations, (2) Equivalent visual operations, and (3) Aircraft trajectory-based operations.

Super-density operations will entail reduced aircraft wake vortex separation standards and less restrictive runway/taxiway operations.

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.

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.

NASA's AS Program has identified the following Next Generation Air Transportation System (NGATS) Airportal research activities: Optimization of surface traffic; Dynamic airport configuration management; Advanced technologies to detect and avoid wake vortex hazards; New procedures for performing safe, closely spaced and converging approaches at closer distances than are currently allowed; and Modeling, simulation, and experimental
validation research focused on single and multiple regional airports. Inherent within the AS Program approach is the integration of wake vortex 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 NGATS-Airportal effort. The general areas of primary interest are Surface Management Optimization and Wake Vortex Hazard Solutions. Specific research topics for NGATS-Airportal include:

- Airborne spacing algorithms and wake avoidance procedures for airports with closely spaced runways;
- All-weather wake vortex sensors (includes sensor/data processing innovations and basic physics of wake vortex sensing);
- 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 air traffic control tower personnel for optimized surface operations, including push back scheduling and management of airport surface assets;
- Dynamic airport configuration management;
- "Evaluator" integrated solutions for airportal management functions over multiple planning intervals;
- High resolution CFD and real-time modeling of wake vortex strength and location;
- High resolution measurement and/or prediction of terminal area atmospheric profiles (includes sensor and data processing innovations, weather forecasting, and the potential use of aircraft as sensors);
- Human/automation interaction and performance standards;
- Integration of decision-support tools across different airspace domains;
- Methodologies and/or algorithms to estimate environmental impacts of increased traffic on the surface and in the terminal airspace;
- Modeling and simulation of single airport operations for validating taxi planning concepts;
- Optimized 4D trajectory generation and conformance monitoring for surface and terminal airspace operations, including departure and arrival planning for individual flights;
- 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 towers;
- Wake vortex alleviation/mitigation technologies.