New Directions
NASA’s Airspace Operations and Safety Program

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Three mega-drivers have emerged that are shaping the future of aviation

Traditional measures of global demand for mobility—economic development, urbanization—are growing rapidly.

Severe energy and climate issues create enormous affordability and sustainability challenges.

Revolutions in automation, information and communication technologies enable opportunity for safety critical autonomous systems.
NASA Aeronautics Research Six Strategic Thrusts

Safe, Efficient Growth in Global Operations
• Enable full NextGen and develop technologies to substantially reduce aircraft safety risks

Innovation in Commercial Supersonic Aircraft
• Achieve a low-boom standard

Ultra-Efficient Commercial Vehicles
• Pioneer technologies for big leaps in efficiency and environmental performance

Transition to Low-Carbon Propulsion
• Characterize drop-in alternative fuels and pioneer low-carbon propulsion technology

Real-Time System-Wide Safety Assurance
• Develop an integrated prototype of a real-time safety monitoring and assurance system

Assured Autonomy for Aviation Transformation
• Develop high impact aviation autonomy applications
What is the Airspace Operations and Safety Program?

This program integrates the Airspace Systems Program and Aviation System-Safety work.

Projects
- Airspace Technology Demonstrations
- SMART NAS - Testbed for Safe Trajectory-Based Operations
- Safe Autonomous System Operations

Airspace Operations and Safety Program

Develops and explores fundamental concepts, algorithms, and technologies to increase throughput and efficiency of the National Airspace System safely.

Provides knowledge, concepts, and methods to the aviation community to manage increasing complexity in the design and operation of vehicles and the air transportation system.

Continues Airspace Systems Program research, and the aircraft state awareness research and system wide safety research that was previously conducted within the Aviation Safety Program.
Current Aviation Business Environment

- Airline costs: Fuel - 25% and labor - 25%
- Fuel prices remain volatile
- Stiff competition in international market
- Horizontal and vertical integration trend continues (e.g., Delta purchasing refinery)
- Airlines made profit last quarter, but FAA’s modernization budget continues to be stressed
- Focus of research is on increasing fuel efficiency and reducing costs by increased automation while ensuring system-wide safety
Gate-to-Gate Concepts and Technology
### Integrated System Capability ATM Generations

<table>
<thead>
<tr>
<th>ATM +1</th>
<th>ATM +2</th>
<th>ATM +3</th>
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<tbody>
<tr>
<td><strong>Domain-Focused Enhanced System</strong></td>
<td><strong>Integrated Airspace System</strong></td>
<td><strong>System-wide Autonomous Optimized Airspace</strong></td>
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<td>Improved individual domains (e.g., surface traffic flow) with some initial integration between domains</td>
<td>Integration of terminal and en route, integrated surface and arrivals/departures, and system modeling enable predictive capabilities</td>
<td>Dynamic, fully autonomous trajectory services enabling rapid adaption to meet user demand or respond to system perturbations (e.g., weather)</td>
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<td>Provides improved efficiency in each domain at the earliest possible date, supporting airline cost savings and reduction of environmental impact</td>
<td>Provides system efficiency, predictability and reliability gains to further improve airline and ATM network operations and support traffic growth, including UAS</td>
<td>Provides a flexible, scalable, and resilient system to meet significant traffic growth and support changing operators’ business-network models</td>
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<td>Majority of current ASP research is supporting ATM +1</td>
<td>Some current research supports ATM +2</td>
<td>This is beyond NextGen capabilities and requires the development of new concepts</td>
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* Demand based on JPDO IPSA analysis of FAA Terminal Area Forecast and RTCA SC-203 OSED for UAS

Required to achieve projected 3X+ growth in traffic demand, including UAS*
ATM Generations Timeline

ATM +1
Domain-Focused Enhanced System

Known methods, mostly ongoing research

NextGen

ATM +2
Integrated Airspace System

Extends methods, begins significantly new research activities

Full NextGen

ATM +3
System-wide Autonomous Optimized Airspace

Encompasses new complexity and autonomy sciences and innovative ATM concepts

Beyond NextGen

2010 2020 2030
Program Flow

**ATM+1**
- ATD-1
- IADS
- TFM WX
- Separation Assurance
  functional allocation
- Oceanic Efficiency
- SMART NAS

**ATM+2**
- TBO
- Cleaner, cost efficient airspace
- Fully integrated trajectory based airspace

**ATM+3**
- Networked ATM
- Autonomous adaptable airspace

2013  2020  2030  2040

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Program

Project *
AOSP strategic alignment
ARMD strategic alignment

Sub-Projects
Technical Challenges

ATD
ATM+1
Safe, Efficient Growth in Global Ops

SMART-NAS
ATM+2
Real-Time Sys-Wide Safety

SASO
ATM+3
Assured Machine Autonomy

IM-TAPSS

Test Bed

AutoMax

IADS

TBO

SPO

A-TFM

Net-Enabled ATM

UTM

TASEAS
• Airspace Technology Demonstrations

• SMART-NAS Test Bed for Safe, Trajectory-Based Operations

• Safe, Autonomous Systems Operations