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.

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.

Projects

- Airspace Technology Demonstrations
- SMART NAS - Testbed for Safe Trajectory-Based Operations
- Safe Autonomous System Operations
Gate-to-Gate Concepts and Technology

- En Route with Weather Avoidance
- Surface Operations
- Dense Terminal
- Efficient Approaches and Descents
- Flow and Airspace Planning
- Gate-to-Gate Concepts and Technology

- SFO Stratus
- SPO
- S-CD&R
- PDRC
- SARDA
- ITP
- EDA/3D-PAM
- DWR
- ATD-1
- Terminal CA
- Dense Terminal
Integrated System Capability ATM Generations

ATM +1  
Domain-Focused Enhanced System

- Improved individual domains (e.g., surface traffic flow) with some initial integration between domains
- Provides improved efficiency in each domain at the earliest possible date, supporting airline cost savings and reduction of environmental impact
- Majority of current ASP research is supporting ATM +1

ATM +2  
Integrated Airspace System

- Integration of terminal and en route, integrated surface and arrivals/departures, and system modeling enable predictive capabilities
- Provides system efficiency, predictability and reliability gains to further improve airline and ATM network operations and support traffic growth, including UAS
- Some current research supports ATM +2

ATM +3  
System-wide Autonomous Optimized Airspace

- Dynamic, fully autonomous trajectory services enabling rapid adaption to meet user demand or respond to system perturbations (e.g., weather)
- Provides a flexible, scalable, and resilient system to meet significant traffic growth and support changing operators’ business-network models
- This is beyond NextGen capabilities and requires the development of new concepts
- Required to achieve projected 3X+ growth in traffic demand, including UAS*

* Demand based on JPDO IPSA analysis of FAA Terminal Area Forecast and RTCA SC-203 OSED for 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
• Airspace Technology Demonstrations

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

• Safe, Autonomous Systems Operations
Airspace Operations and Safety Program (AOSP)

Leighton Quon
Project Manager
Airspace Technology Demonstration (ATD) Project
ATM Technology Demonstration-1

**ATD-1:** Improve arrival operations efficiency while increasing arrival throughput using integrated aircraft-based and ground-based automation technologies

**Utilizes:**
- ADS-B Out/In
- RNAV arrivals
- Optimum profile descents (OPDs)

**Controller-Managed Spacing (CMS) in Terminal Airspace**

**Flight Deck Interval Management (FIM) for Arrival Operations**

**Traffic Management Advisor with Terminal Metering (TMA-TM)**

**FAA’s Terminal Sequencing & Spacing (TSS)**
ATD-1 Delivers to NextGen

- ATD-1 transferred Terminal Sequencing and Spacing (TSS) technologies to the FAA in 2013
- TSS enables use of underutilized modern avionics and Performance-Based Navigation or PBN procedures

- Estimated benefit to airlines operating at 35 benchmark airports ranges from $100-200M/year
- FAA is planning for Initial Operating Capability in 2018

This is an unprecedented contribution of NASA technology to NextGen
Integrated Arrival/Departure/Surface Operations (IADS): Simultaneously increase arrivals, departures, and surface operations efficiency while increasing overall throughput.
IADS Benefits Roadmap

Max theoretical

Unimpeded operations in all traffic and visibility conditions

Incremental Benefits

Flight-deck-based conformance and surface visibility enhancement

Ground-based schedule conformance

Integrated arrival, departure and surface scheduling – gate to gate

ATD-2

Δ Years

0 5 10 15
Applied Traffic Flow Management

Domestic:
- Integrated solutions are to extend NASA already developed Domestic ground/air capabilities for individual aircraft to overcome these current TFM challenges opportunistically to achieve reduced lengths of conservative re-routes, ground holds and stops, Miles-In-Trail for multiple aircraft, into web based tools
- Estimated $79M per year nationwide savings to US airspace users

Oceanic:
- Integrated solutions are to extend NASA already developed Oceanic capabilities for aircraft to

Pacific: 1600 lb fuel reduction per aircraft
North Atlantic: 750 lb fuel reduction per aircraft
Technologies for Assuring Safe Energy and Attitude State

- CAST’s Airplane State Awareness Joint Safety Implementation Team (ASA JSIT) Recommended Research Safety Enhancements (SEs)
- NASA’s precursor safety focus to *Increase Pilots’ Ability To Avoid, Detect, And Recover From Adverse Events That Could Otherwise Result In Accidents/Incidents*

**Cause and Effect**

**Safety Enhancements**