Simulation Accomplishments

NASA Langley Research Center is developing and testing new ideas for the Next Generation Air Transportation System using realistically modeled aircraft systems and environments in the Air Traffic Operations Lab. Accomplishments include:

Distributed Air-Ground Traffic Management (DAG-TM) – development and feasibility assessment of an advanced operational concept for future air traffic management, where information and decisions are distributed appropriately between air and ground participants. Airborne decision tools for airborne conflict management, traffic flow management constraint conformance, arrival merging and precision spacing were designed, developed, and tested in piloted simulations up to 3X traffic levels.

Airborne decision tools improve airport efficiency

Small Aircraft Transportation System (SATS) - investigated Higher Volume Operations (HVO) at non-towered, non-radar airports. One experiment used low-time IFR pilots to determine if the proposed HVO procedures were safe and viable, and another to determine the workload and usability of the HVO concept for Air Traffic Control. In this NASA/FAA experiment, the ATOL pilot stations were linked to the FAA's William J. Hughes Technical Center in Atlantic City, NJ. Other experiments used IFR rated pilots to explore proposed emergency procedures for HVO.

AviationSimNet™ – a set of simulation standards and protocols enabling geographically diverse facilities to interconnect and conduct joint real-time simulations. Langley joined Mitre-CAASD as a charter member with public demonstrations in 2005. All aviation simulation facilities are invited to join AviationSimNet™.

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Air Traffic Operations Laboratory

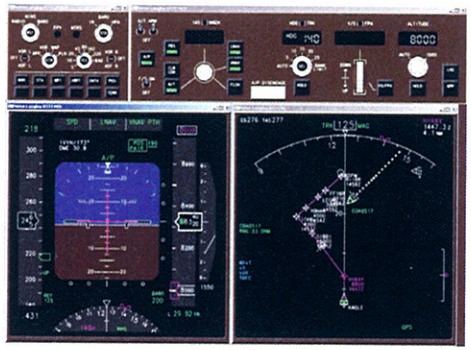
Airspace and Traffic Operations Simulation

The Air Traffic Operations Laboratory (ATOL) is a simulation facility where NASA evaluates new air traffic management (ATM) concepts, maintaining appropriate levels of compatibility with real-world avionics system architectures and emerging National Airspace System (NAS) infrastructure. The simulation environment is called the Airspace and Traffic Operations Simulation (ATOS). It is comprised of over 20 computer workstations that are used as pilot stations flown by real pilots. These simulated aircraft can interact with each other in a simulated airspace and traffic environment in various configurations and air traffic scenarios. ATOS includes the ability to insert hundreds of additional automated aircraft and to connect high-fidelity flight-deck simulators as part of the traffic environment. The lab can also support 'pseudo-pilot' (i.e. multi-aircraft) control and remotely piloted and non-piloted aircraft operations.

ATOS is the simulation environment within the ATOL

The ATOL can be connected to ATM simulation labs in other parts of the country either via a secure T1 line or over the Internet using the open standards of AviationSimNet™. When connected to other ATC simulations, the ATOL supports the ability to have live controllers interact with the pilots through voice and data link communications.

This concept-level distributed traffic simulation environment is used for operational feasibility assessments, system-level requirements definition, airborne and ground-based communication, navigation, and surveillance (CNS) technology requirements determination, and human-centered design and assessment of ATM concepts and flight-deck systems. A workstation-based aircraft simulation referred to as the Aircraft Simulation for Traffic Operations Research (ASTOR), is designed to replicate the displays and controls of modern transport and general aviation aircraft. Each ASTOR hosts advanced decision aids and airborne CNS systems, including high fidelity Automatic Dependent Surveillance Broadcast (ADS-B) models.

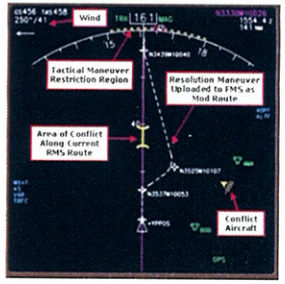


ASTOR display of simulated flight-deck systems

Although ATOS is designed for research, its simulated systems are designed to interface and integrate with real avionics architectures and flight deck procedures to every extent possible. Also considered in the design are current guidelines and standards that the aviation industry is developing for future architectures.

Performance-Based 4D Trajectory Operations

In collaboration with other Government agencies, industry, and the international R&D community, NASA is developing, researching, and maturing components of the Next Generation Air Transportation System (NGATS). To support NGATS research, NASA is continuing development of interactive flight-deck decision support tools, such as the Autonomous Operations Planner (AOP).



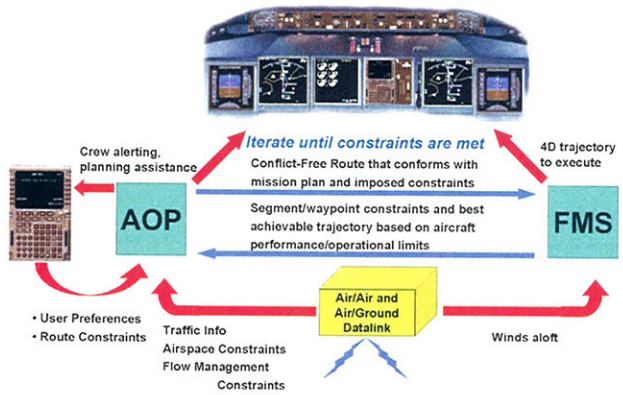
Autonomous Operations Planner

AOP is a tool set that functions as an Airborne Separation Assistance System (ASAS) for advanced performance-based 4D trajectory flight operations. This '4D-ASAS'-development effort supports NGATS research to significantly increase capacity of the NAS, while maintaining or improving safety. 4D-ASAS enables aircraft pilots to maintain traffic separation while conforming to traffic flow management constraints assigned by ground-based Air Traffic Service Providers.

AOP 4D trajectory with conflict detection

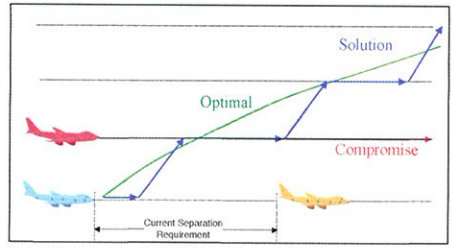
NASA is also developing airborne precision spacing (APS) flight guidance to help increase arrival efficiency and throughput at capacity-limited airports. APS allows the pilots to manage their speeds during descent and approach, to space precisely relative to another aircraft. By increasing precision with which aircraft are spaced, they can be safely spaced more tightly, allowing more aircraft to land during a period of time and decrease en-route delays.

APS improves airport efficiency and throughput



Integration of the AOP with the FMS and flight deck systems

Oceanic operations, due to extended periods out of radar coverage have large longitudinal and lateral separation minima. These provide safe operations, but ones that are often not fuel-efficient. Current research uses the oceanic domain as a place to investigate a phased approach to integrating the various levels of separation authority delegation in a constrained 4D environment (in other words an opportunity to begin looking at 4D-ASAS). Use of airborne surveillance and onboard tools can facilitate altitude changes for greater fuel efficiency, from a phase 1 Altitude Change Request Advisory Tool to a phase 4 ASAS on a track. The ATOS provides an exceptional environment for this research.



Oceanic domain for phased approach to 4D-ASAS

Small Aircraft Transportation System

A portion of the ATOL has been specially designed to investigate issues unique to General Aviation (GA), specifically integrating unscheduled operations into the NGATS and flight operations at airports without Air Traffic Control (ATC) services. This GA portion of ATOL can also be run in single-pilot, multi-pilot, or remote-site linked simulation experiments, all with or without virtual traffic and/or voice communications. The ATOL supports combinations of up to eight real pilots in the loop in various combinations.

Artist's rendering of SATS concept

Each of the eight GA pilot stations has two 21" LCD monitors for displaying cockpit instrumentation, a 50 in display for out-the-window views, a yoke, rudder pedals, and Voice over IP. Internet connectivity that provides for voice, data, and video during linked simulations.

The following unique software provides high-fidelity simulation functionality:

- General Aviation simulator contains the aircraft performance characteristics model, drives the Multi-Function Display, provides logic for Pilot Advisor information, and computes Conflict Detection and Alerting.
- Target Generator generates virtual traffic (used for batch and Monte Carlo studies) and includes pilot error model.
- Airport Management Module is software unique to the SATS concept that computes the landing sequence at non-towered, non-radar airports for arriving aircraft.
- Simulation Control: Higher Level Architecture (HLA) compliant, data and voice control.