National Aeronautics and Space Administration

Intelligent Automation Inc. is optimizing air traffic in high-population cities.

Air Traffic Simulation Technology for High-Population Metroplexes

Challenge

While NASA is known for its space technology innovations, it is also an authority in aeronautics on Earth under the Aeronautics Research Mission Directorate, with a specific mission to lead a new era in air travel called Advanced Air Mobility (AAM)[1]. The vision of AAM is to create a safe and efficient air transportation system where everything from small package delivery drones to passenger-carrying air taxis operates above populated areas. With this vision, NASA is interested in better management and understanding of air traffic in metroplexes—high-population cities where air traffic meets a number of constraints, including safety, noise, emissions, tall buildings, and low-level winds. NASA sought a tool that could accurately predict and analyze air traffic to help mitigate delays and other issues at airports in metroplexes, leading the way for the future of aviation.

Solution

Intelligent Automation, Inc. (IAI), a science and technology solutions provider in Rockville, MD, responded to the NASA SBIR/STTR Program's solicitation for a metroplex analysis tool. The small business has a track record of developing air traffic management technology under the SBIR/STTR Program for agencies including the Department of Defense (DOD) and the Department of Transportation (DOT), as well as various other technology solutions for NASA.

[1]www.nasa.gov/aam

Project

MetroSim, a fast-time airport traffic simulation tool for optimizing and analyzing flights in metroplexes

Mission Directorate

Aeronautics Research

Phase III Success

The development of MetroSim with the NASA SBIR/STTR Program led to more than $2M in additional funds from NASA, FAA, DOT, the Port Authority of New York and New Jersey, and Navy

Snapshot

IAI's MetroSim optimizes air traffic by simulating departures, arrivals, and activity in air and on the ground in busy metroplexes, where flights impact each other at a single airport and among traffic at nearby airports. MetroSim evolved out of several NASA SBIR/STTR Awards and has since been used by NASA for flight simulation analysis. MetroSim has also been integrated with FAA and DOT technology, has produced studies for the Port Authority of New York and New Jersey, and is under development to support the Navy

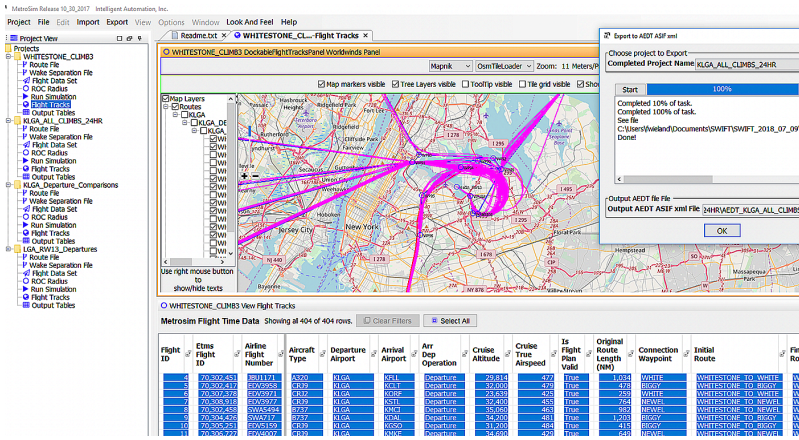
Intelligent Automation, Inc.
15400 Calhoun Drive, Suite 190
Rockville, Maryland 20855

i-a-i.com

IAI's solution to NASA's call was MetroSim, a tool that simulates airport traffic in the air, on the ground, and during departures and arrivals between neighboring airports in a metroplex. MetroSim allows airport planners, traffic flow management experts, airline dispatchers, air traffic controllers, and pilots to reduce the uncertainty in operations planning, recover quickly from disruptive events, maintain high throughput even in adverse weather conditions, and handle the uncertainties associated with weather forecasts. The most notable feature of MetroSim is its ability to simulate the interaction of high-volume airport traffic within a metroplex, where airspace is congested and requires considerable and careful optimization to ensure safety and efficiency.

MetroSim uses a system built under a previous NASA SBIR Award, called the Kinematic Trajectory Generator (KTG)—a control-theory model portraying the state of aircraft computed every half second of simulation time. Frederick Wieland, Director of Air Traffic Management Research and Development at IAI, explains how the various components of MetroSim make the simulation possible: "For optimization, we use mixed integer linear programs. We basically set up a set of mathematical equations to determine the most optimal situation. We also have a proprietary waypoint scheduling system and we have KTG, which uses control theory to compute the location of aircraft. All three together make MetroSim unique."

MetroSim's first module simulates ground activity of an aircraft, such as when an aircraft moves from a gate to a departure runway. The second module looks at airport configuration and weather, attempting



Metrosim's user interface displays flight tracks of airplanes in a metroplex.

to optimize runway configuration according to traffic load and weather conditions. The third module takes a holistic view of the metropolitan region and manages the constraints among different airports. These three layers communicate with each other to optimize the air traffic across all layers, enabling a user to study the most efficient air traffic environment.

Business Impact

The initial implementation of MetroSim for NASA led IAI to several new business opportunities, both with NASA and beyond. While MetroSim was originally built for commercial and transport aircraft, IAI adapted the technology to small UAVs when NASA's Ames Research Center expressed additional interest in AAM.

MetroSim was also recognized by the Federal Aviation Administration (FAA), as the agency had new initiatives around reorganizing metroplex airspaces, and by DOT. As MetroSim was integrated with DOT's Aviation Environmental Design Toolkit, it received attention from the Port Authority of New York and New Jersey, which awarded IAI a Phase III Award to use MetroSim in analysis of their metroplex air traffic. Most recently, IAI is developing a simulation tool for the Navy that uses MetroSim-related technology as the basis for its simulation system.

> "The SBIR program has been a blessing for us. We don't have a lot of funding for research and development, so the SBIR program has helped us develop programs like MetroSim, which has helped us impact not only NASA but also Port Authority, FAA, DOT, and Navy.
>
> – Frederick Wieland
> Director, IAI