National Aeronautics and Space Administration

NASA

Airspace Systems Program Newsletter

QUARTER 2: JAN–MAR 2012

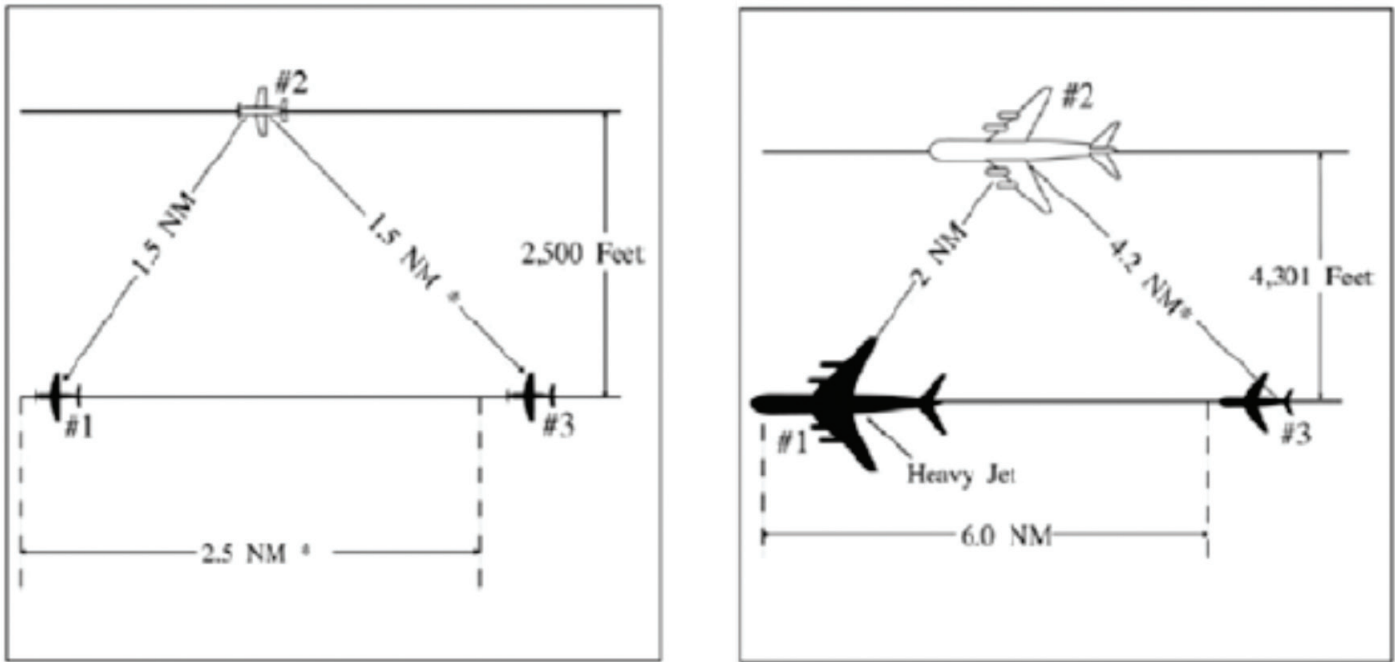www.nasa.gov

// Technical/Programmatic Highlights

Figure 1. Separation minima for dependent parallel approaches.

EFICA RTT's IMSPiDR1 Efforts Wrapping Up, April 2012

Most air transportation forecasts predict increases in both the number of passengers that will travel by way of U.S. commercial air carriers and in the number of cargo and passenger aircraft. If the efficiency of current operations is not improved, this projected increase in flight operations will lead to greater noise, pollution, delays, fuel costs, and infrastructure requirements. Airports are a critical node in this complex network. A key to airport efficiency is the ability to schedule, and then manage, the aircraft-to-aircraft spacing at runway thresholds. Increasing runway throughput through precision control is one method that can minimize the need for new infrastructure, and airborne spacing has

been proposed as a viable way to effectively increase that runway throughput. The most challenging and complex situation is arrival operations to parallel dependent runways. There are complexities not present for arrivals to single or parallel independent runways. Airborne precision spacing tools must be able to compensate for runway threshold offset and change aircraft separation minimums once both are on their respective final approach path to the parallel runways.

NASA research of precision control for arrival operations began in the 1970s by exploring "constant distance" and "constant time" spacing techniques along a common trajectory. In 2006, the NASA research team joined the Interval Management (IM) working group, led by the Federal Aviation Administration's (FAA) Sur-

veillance Broadcast Services (SBS) Office. This group contains members from the FAA, controllers, pilots, researchers, and aircraft avionic manufactures, and drafted a concept of operations for air traffic management procedures that would capitalize on the aircraft's onboard ability to precisely control to an assigned spacing. In IM, the flight crew is responsible for flying their aircraft at a speed that achieves their assigned spacing interval at the runway threshold, while Air Traffic Control (ATC) remains responsible for ensuring that all aircraft maintain safe separation. In 2008, NASA and the FAA also agreed to include this body of work in the Efficient Flows into Congested Airspace Research Transition Team (EFICA RTT). Initial efforts focused on single runway operations; however, several airports routinely conduct parallel approach operations and subsequent efforts incorporated this increasing complexity. Over the last several years, the concepts, procedures and algorithms from these joint efforts have matured into a trajectory-based algorithm that accommodates complex route structures arriving to the airport from all directions.

The IM with Spacing (IM-S) concept employs both a ground-based scheduling component and a flight deck-based spacing component. The ground-based component is software that creates an optimized schedule of arrival times for all aircraft to each runway, the spacing between those aircraft, and then provides the controller a message to send to the flight crew. The controller sends the message and delegates control of the aircraft's speed to the flight crew for them to achieve this precise spacing at the runway threshold. The flight-deck based spacing software, called Airborne Spacing for Terminal Arrival Routes (ASTAR), calculates the speed for the crew to fly based on the specified 4D trajectory of their aircraft and traffic to follow to achieve the assigned spacing interval. As depicted in the illustrations in Figure 1, the spacing tool onboard the IM aircraft (#3) receives the ADS-B broadcasted position of the lead in-trail aircraft (#1) and parallel aircraft (#2). The algorithm calculates the required speed to achieve the assigned interval behind the aircraft proceeding to the same runway, and the speed to achieve the assigned interval behind the aircraft proceeding to the parallel runway.

Interval Management with Spacing to Parallel Dependent Runways (IMSPiDR1) was a human-in-the-loop experiment conducted in June 2011 at NASA Langley with 24 commercial pilots flying arrivals to runways using dependent parallel operations at Dallas Fort-Worth airport (DFW). The overall goal of the experiment was to examine the ability of airborne spacing software and procedures to support ATC by precisely delivering aircraft at the runway in both in-trail and dependent parallel runway operations.

The experiment extends previous research by evaluating the latest version of ASTAR10 which supports parallel dependent runway operations while maintaining the ability to support IM-S and Required Time of Arrival (RTA) operations, and by continuing to refine the pilot interface associated with the use of the algorithm's speed guidance. Research objectives included:

1) examining the algorithm's performance in terms of the precision of aircraft delivery to the runway threshold and the stability of the aircraft arrival streams, 2) observing flight crew interactions with the algorithm, 3) evaluating requirements for ATC-flight crew communication via Controller-Pilot Datalink Communication (CPDLC), and 4) collecting pilots' reported workload levels and ratings of the acceptability of NASA's IM-S concept, procedures, speed guidance, and pilot interface.

Results addressing the first objective indicate that pilots delivered their aircraft to the runway threshold within +/- 3.5 seconds of their assigned arrival time and reported that both the IM-S and RTA procedures were associated with low workload levels. In support of the second objective, pilots in general found the IM-S concept, procedures, speeds, and interface acceptable; with 92% of pilots rating the procedures as complete and logical, and 63% of pilots reporting that the displays were easy to understand and displayed in appropriate locations. Concerns cited included the occurrence of multiple speed changes within a short time period, speed changes required within twenty miles of the runway, and an increase in airspeed followed shortly by a decrease in airspeed.

The results addressing the third objective were very successful, with the mean time under 43 seconds for the flight crew to load the clearance into the IM spacing tool, review the calculated speed, and respond to ATC. An overall mean rating of 'Moderately Agree' was given when the crews were asked if the use of

CPDLC was operationally acceptable as simulated in this experiment. Approximately half of the flight crew reported the use of CPDLC below 10,000 feet for IM operations was unacceptable, with 83% reporting below 5000 feet was unacceptable. Also described are proposed modifications to the IM operations that may reduce CPDLC 'Respond' time to less than 30 seconds and should significantly reduce the complexity of crew procedures, as well as follow-on research issues for operational use of CPDLC during IM operations.

While the formal results from the first objective are waiting to be published, complete papers documenting the results from the second and third objective mentioned above can be found at:
http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/ 20110015876_2011016836.pdf and
http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/ 20110015885_2011016849.pdf
(POC: Brian Baxley)

Expanded Discussion About Use of PDRC, January 2012

NASA and FAA discussed forming a collaborative effort to improve the FAA's coupling of advanced airspace and surface air traffic tools for Dulles International Airport (near Washington, D.C.). To enable the transfer of information from an automated surface scheduling tool to an airspace management tool, the FAA is exploring the NASA-developed Precision Departure Release Capability (PDRC). PDRC enables the automatic transfer of predicted take-off surface

information to improve en-route and arrival scheduling at other airports. It was tested at the Dallas-Fort Worth (DFW) Airport in 2011 and plans include continued DFW field evaluations. This FAA project is expected to continue for multiple years with increasingly more complex field evaluations in each successive year. *(POC: Shawn Engelland)*

## ATM Data Warehouse Upgrade Complete, January 2012

The NextGen Air Traffic Management (ATM) Data Warehouse has been upgraded to support remote access and user-specific customizations by all NASA researchers and research partners. The ATM Data Warehouse is a secure, web-based user interface to an Oracle database currently containing eight terabytes of raw and processed air traffic and weather data for the United States. The warehouse contains two years of recorded and processed data so far, and is growing by 300 gigabytes per month. The processed data include all relevant sources of flight and weather data, including recorded radar feeds and national traffic data from many FAA facilities. The warehouse also includes several types of wind and convective weather data and predictions for the airport surface as well as en-route airspace. The processed data types are searchable and represent critical analyses of general interest, broken down by date, time, and location. The processed data include airport landing rates, national and local delays, national traffic advisories, and the impact of convective weather on flight routing. More functions are being added continuously

based on the needs of ATM researchers at both Ames and Langley Research Centers. For additional information on access, NASA researchers and research partners are encouraged to contact Michelle Eshow at Michelle. Eshow@nasa.gov for a data warehouse account. *(POC: Michelle Eshow)*

NASA/US Airways Collaboration Meeting, January 2012

Researchers and managers from NASA and US Airways met at Ames Research Center to discuss joint research and development efforts to improve surface operations at Charlotte Douglas International Airport (CLT). NASA researchers presented current research activities and surface simulation capabilities to US Airways
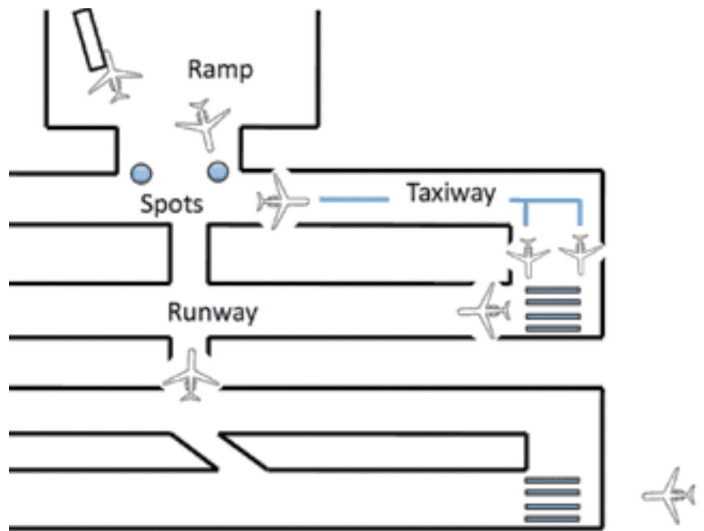

The Spot and Runway Departure Advisor (SARDA) helps to improve the efficiency of airport surface operations involving the ramps, spots, taxiways, and runways.

representatives and also demonstrated the Spot And Runway Departure Advisor (SARDA) tool at NASA's FutureFlight Central (FFC) simulation facility. SARDA, a decision support tool for tower controllers, is undergoing continued development and preparations for an FY12 human-in-the-loop simulation. US Airways presented an overview of airline operations at CLT, the tools that are being used by ramp operators, and the simulation tool that is being used for developing traffic plans. Both research teams discussed topics for collaboration, including data sharing/analysis, development of an operational concept of a tool for both airline and ATC operations, modeling and simulation of CLT operations, and conducting a field evaluation of a developed tool. Both NASA and US Airways agreed to take the next steps to develop a formal plan for collaboration. *(POC: Yoon Jung)*

DWR Planning Meeting with American Airlines and Fort Worth Center, January 2012

"When can we start?" That was the response from Captain Jeff Osborne, managing director of the American Airlines System Operations Center (SOC), following a meeting and demonstration of the Dynamic Weather Routes (DWR) tool at the NASA/FAA North Texas (NTX) field site. Capt. Osborne, Des Keany, head of flight planning, and others from American Airlines along with the Fort Worth Center (ZFW) Traffic Management Officer Sam Pacifico, participated in discussions about the proposed DWR operating concept
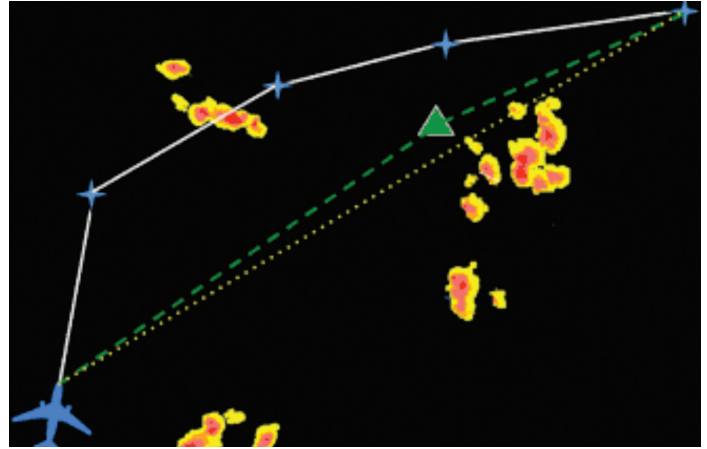
Example of a dynamic weather reroute.

and a potential operational trial of the DWR technology in 2012. The operating concept calls for DWR automation at NTX with dispatcher displays at the American SOC and traffic management coordinator displays at the ZFW Traffic Management Unit. Both American Airlines and Fort Worth Center management strongly support a field trial of DWR at Fort Worth Center. NASA researchers are working to formalize FAA Headquarters support and to complete development and testing for the DWR operational trial. *(POC: Dave McNally)*

Two Air Quality NRAs Begin, January 2012

The NRA team led by Dr. Steven Barrett from MIT, which includes Mosaic ATM and ATAC, presented their research plan for the assessment of ozone (O_3) and particulate matter (PM) impacts due to airport surface operations. Surface operations play a major part in the efficiency of the air transportation system, and the

impacts of fuel burn, emissions, air quality, and noise at and near airports are of great interest to the public. O3 and PM are of particular importance to air quality, more so as many major U.S. airports lie in environmental non-attainment areas. The approach will include the development and validation of real-time models that evaluate emissions impacts (and the associated air quality impacts) of aircraft surface operations. A goal is to include these models with one of NASA's Surface Decision Support tools and develop a plan for the integration of the proposed models with the FAA's Aviation Environmental Design Tool (AEDT). Specific topics included a description of NASA's surface research, a description of the roles of each team member, overview of air quality models, and methods to estimate ground fuel burn.

Dr. Brian Kim (Wyle) and Dr. Saravanan Arunachalam (University of North Carolina) presented their plans to develop modeling capabilities for predicting air quality impacts due to aircraft movements near airports. NASA is currently researching how to shorten the amount of time an aircraft spends taxiing before takeoff to alleviate some of the congestion on the airport surface. Reduced taxi times will help to eliminate unnecessary fuel burn, resulting in fewer emissions and less impact on the environment. A goal of this research is to translate those impacts into air quality metrics for particulate matter and tropospheric ozone. During this meeting the team presented an overview of air quality models and their work plan.
*(POC: William N. Chan)*

Airport Surface Management NRA Kickoff Meeting, February 2012

NASA hosted the NRA kickoff meeting on the topic of Airport Surface Management Requirements Resulting from Variation in Airport Characteristics. Dr. Steve Atkins from Mosaic ATM, principal investigator of the effort, presented the scope of the work and discussed work plans for the base year with NASA researchers. NASA's Safe and Efficient Surface Operations (SESO) research focus area has developed and studied a Spot and Runway Departure Advisor (SARDA), which plans spot crossing times and runway sequences for departures at DFW. The high-level goal of this NRA is to help NASA extend its airport surface traffic management (ASTM) research to other airports. To accomplish this the NRA will consider the characteristics that affect what types of ASTM functions are needed at an airport, and will model three airports with different characteristics such as number of spots, runway geometry, and number of taxi queues feeding each runway departure end. Using these characteristics, Mosaic will model SARDA and possible SARDA extensions, such as runway assignment or taxi routing advisories, in Mosaic's Metroplex Simulation Environment. Lastly, the NRA will perform fast-time simulations to understand which ASTM functions are most relevant as a function of the airport characteristics.
(POC: Ty Hoang)

Bowe and Santiago Recognized by the NSBE for Outstanding Technical Contribution, February 2012

 "Evaluation of a Fuel-Efficient Maneuver for Conflict Resolution" was recognized from among 40 other technical papers across all tracks at the recent National Society for Black Engineers (NSBE) Aerospace Conference to receive the award for Outstanding Technical Contri-
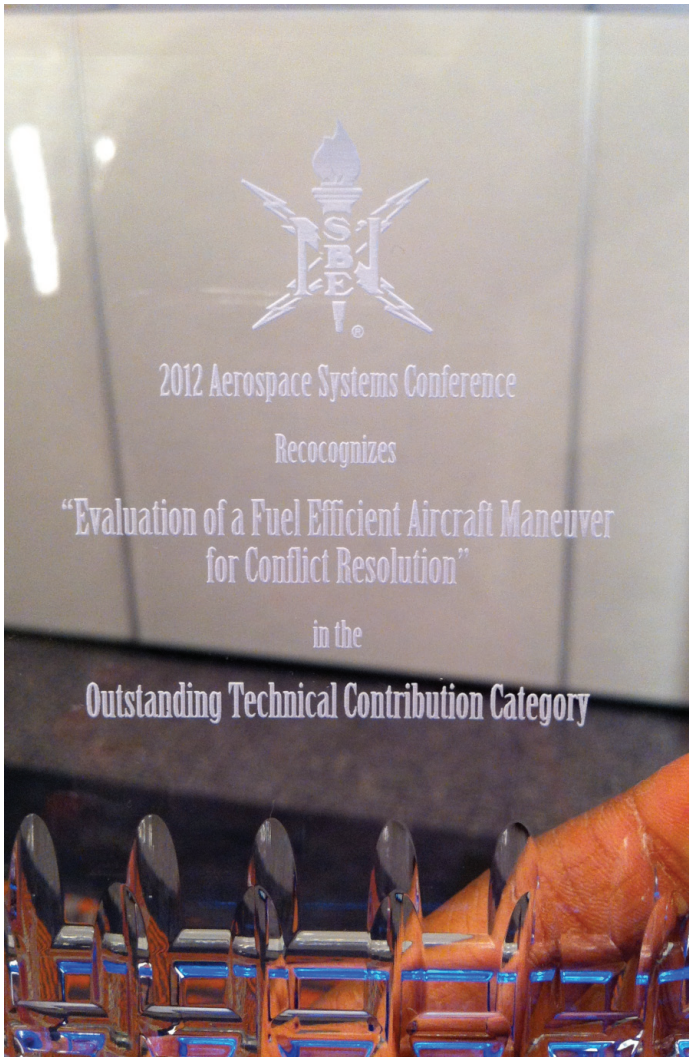
Dr. Edward Tunstel (left) and Reginald Gillins (right), (NSBE Technical Program Co-Chairs) present the Outstanding Technical Contribution Award to Aisha Bowe (center) of NASA's Ames Research Center.

bution. The paper quantifies the potential operational benefits of using a combined speed-reduction/direct-to maneuver to resolve projected aircraft conflicts on a 5- to 20-minute time horizon. In a February ceremony, authors Aisha Bowe and Confesor Santiago were cited for the exceptional quality, innovation and experimentation reflected in their work.
(POC: Aisha Bowe)

NASA/FAA Team Reviews Dynamic Airspace Research, February 2012

 A meeting of the NASA/FAA Research Transition Team (RTT) for Dynamic Airspace Configuration

(DAC) was hosted by the Air Traffic Control System Command Center, located in Warrenton, Virginia (Washington, D.C. area). There were more than 20 participants representing NASA, FAA, and MITRE/CAASD. NASA researchers presented their work on an analysis of Cleveland Center airspace redesign and the development of an advisory tool that helps supervisors dynamically allocate available controller and airspace resources to match air traffic demand. The NASA team received valuable feedback from FAA personnel about operational and programmatic considerations. FAA participants provided briefings on current projects for improving operations in the National Airspace System. The general consensus is that NASA's DAC research is supportive of long-term NextGen advancements. *(POCs: Karl Bilimoria, Michael Bloem)*

PDRC Operational Evaluation Walkthrough, February 2012

NASA and FAA recently participated in a walkthrough of operational evaluation scenarios for the Precision Departure Release Capability (PDRC). NASA has developed PDRC to improve tactical departure operations through the use of surface information for en route tactical departure scheduling systems. FAA traffic management coordinators from Fort Worth ARTCC and Dallas/Fort Worth TRACON and Towers exercised the PDRC system during the overview in the North Texas (NTX) Research Station laboratory. NASA researchers presented the FAA operational personnel with various display configurations and evaluation

A PDRC walkthrough at North Texas (NTX) Research Station Laboratory.

usage scenarios. The FAA participants provided valuable feedback that the research team is using to refine the system configuration and test plan. Elements of the PDRC system are currently being deployed to FAA operational areas in preparation for the operational evaluation to be conducted this spring. *(POC: Shawn Engelland)*

SARDA Pre-Sim Systems Checkout, February 2012

The SARDA team brought in two retired DFW controllers as Subject-Matter Experts (SMEs) to aid with system checkout of SARDA prior to data collection runs. Their expertise was sought for the following topics: 1) Future Flight Central's out-the-window (OTW) visuals, 2) electronic flight strips (EFS), 3) use of traffic management initiatives (TMI), 4) scenario

Dallas-Fort Worth Airport.

traffic files, and 5) operational use. Feedback for the OTW was minimal, requiring just some background color changes (from sandy to shrubbery green) to allow more contrast of arrivals prior to touchdown. The aircraft models have also been upgraded to reflect current air carrier flags, flight IDs, and call sign usage (especially for merging airlines, United/Continental and AmericaWest/US Airways). As a result of the week's testing, the SARDA team will re-evaluate the need for representing the Runway 17L arrivals. The amount of traffic placed upon the 17L arrival would nominally warrant the opening of a second local controller position and the use of the perimeter taxiway. The SME's recommendation is to remove the 17L traffic, thus elimination of the use of the perimeter taxiway, and the second local position. The SME's also gave recommendations on scenario generation and traffic loading profile as well as operational procedures for the pseudo-pilot to adopt for next system checkout. The team will use these recommendations to refine the SARDA

algorithms and user interfaces to reduce simulation distraction and place focus on the SARDA technologies during the data collection runs. System checkout #3 will take place in April with the simulation occurring prior to the end of fiscal year.
(POC: Ty Hoang)

Observation of Charlotte Airport Surface Operation, February 2012

Researchers from NASA and NRA partners Saab Sensis traveled to North Carolina to observe flight operations on the surface at Charlotte Douglas International Airport. They toured both the FAA air traffic control tower and the US Airways ramp control tower. Valuable information about gate, ramp, taxi, and runway procedures, in addition to first hand observations from the towers, was collected. The information will be used to enhance NASA's fast-time simulation of airport flight operations, named the Surface Operation Simulator and Scheduler (SOSS). SOSS is being used to develop
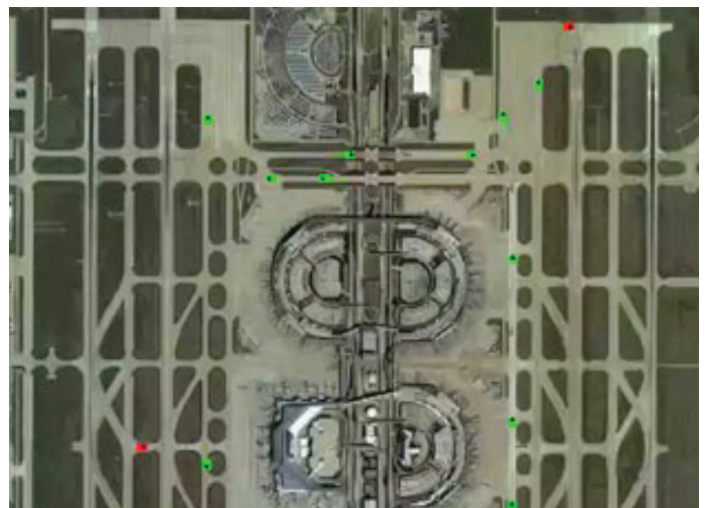
The Surface Operation Simulator and Scheduler.

tools for sequencing and scheduling departures and runway crossings at busy airports. The tools are designed to reduce the time that flights must wait on the taxiway before takeoff. Less time spent on the taxiway translates to less fuel burn, emissions, and noise at the airport. *(POC: Robert Windhorst)*

Air Traffic Management Future Concepts Team Meeting, February 2012

Senior FAA and airline representatives from the Future Concepts Team received a review of NASA's Air Traffic Management work during their visit to NASA's Ames Research Center. The team is part of the Collaborative Decision Making group, which is a joint FAA/industry initiative aimed at improving air traffic flow management through increased information exchange among aviation community stakeholders. During this meeting, NASA provided updates of their Air Traffic Management research as well as updates to FAA-funded work. FAA-funded work is aimed at understanding how Traffic Management Initiatives performed and how previous performance can inform future decisions. This effort includes database development as well as machine learning research to develop relationships among disparate datasets. NASA also presented their work in airport surface scheduling, en-route dynamic weather routing, dynamic airspace configuration, and controller managed spacing. The team also received tours of the Vertical Motion Simulator, FutureFlight Center, Crew-Vehicle Systems Research Facility, and wind tunnels. During the last day, the FAA and airlines hosted a panel discussion on future concepts. This

Future Concepts Team panel discussion.

meeting was also reported in the Collaborative Decision-Making Group's February newsletter. *(POC: Kapil Sheth and Joey Rios)*

ATD-1/REACT Simulations, March 2012

The ATD-1/REACT simulations in Ames' Aviation Systems Division's Air Traffic Control Simulation Lab included FAA and NATCA participants and studied the effects of integrating new Area Navigation/Required Navigation Performance (RNAV/RNP) enabling technologies into the Terminal Area Precision Scheduling and Spacing (TAPSS) System. The simulation controllers, funded and supplied by the FAA, conducted 15 simulation exercises during high demand periods. Using the NASA tools, the controllers were able to provide more PBN (Performance Based Navigation) clearances and maintain higher throughput. The simulation hosted FAA visitors Rob Hunt, NextGen solution set coordinator, and Balinda Moreland, time-based flow management lead technical engineer. The simulation was also witnessed by Aeronautics Research

NASA's Ames Research Center welcomes ATD-1/REACT simulation participants.

Mission Directorate Associate Administrator Jaiwon Shin, Boeing Chief Technical Officer John Tracy, and directors for NASA's Fundamental Aeronautics and Airspace Systems Programs.
(POC: John Robinson)

Peninsula High School Students Learn About Air Traffic Control Careers, March 2012

A group of ninth-grade students from San Mateo High School, Calif., were given a unique opportunity to transfer problem-solving skills from the classroom to the real world. NASA and the Federal Aviation Administration (FAA) hosted a field trip packed with authentic air traffic control experiences for the students at the FAA's Oakland Air Route Traffic Control Center in Fremont, Calif. The two-hour field trip was part of NASA and the FAA's partnership in promoting science, technology, engineering and mathematics (STEM) education and related careers using a NASA education project called "Smart Skies." The project uses the theme of air traffic control to connect mathematics, problem solving, and decision-making skills to the real world.

Students were given a unique opportunity to transfer problem-solving skills from the classroom to the real world.
Image credit: NASA Ames Research Center / Dominic Hart

"When air traffic controllers guide planes from departure to arrival, it's all math and science behind the scenes," said Tom Davis, chief of the Aviation System Division at NASA's Ames Research Center, Moffett Field, Calif. "Math is the foundation to many things you will want to do in life," Davis told the students assembled in the Air Traffic Control (ATC) conference room.

Seated in the executive chairs used by air traffic controllers when briefed each morning, the 15 students also were briefed on the field trip's agenda, which included a tour of the control room floor, a training exercise in the Dynamic Simulation (DySim) laboratory, and an opportunity to test their skills on iPads via a NASA air traffic control mobile game called "Sector 33."

In preparation for the field trip, the students used NASA's Smart Skies "LineUp With Math" web-based simulator in the classroom to learn the proportional reasoning skills used to solve real-life distance-rate-time problems in air traffic control. The Sector 33 game is based on Smart Skies LineUp With Math, and is

NASA and the Federal Aviation Administration (FAA) hosted a field trip for a group of ninth-grade students from San Mateo High School, Calif., at the FAA's Oakland Air Route Traffic Control Center in Fremont, Calif.
Image credit: NASA Ames Research Center / Dominic Hart

a mobile application currently available for the iPad, iPhone, and iPod touch. Both products were developed under the direction of NASA's Aeronautics Research Mission Directorate and distributed in cooperation with the Federal Aviation Administration and National Air Traffic Controllers Association. The math-focused games align with the NASA Office of Education's mission to engage students in activities related to science, technology, engineering and mathematics.

"After students learned how to use Smart Skies and were given time to practice it, they started showing initiative. They started moving on to more advanced mathematical problem-solving by themselves," said Marco Rainaldi, the students' mathematics teacher who has been teaching the subject for the past seven years.

In the DySim lab, students received instruction from air traffic controllers about how to use computer training modules that are used by their own personnel. "This is the ultimate video game," one teacher told a student. "But you have to be right every time."

Students moved from one activity to another, sharing their reactions with each other about the games they played, the people they met, and the technology they saw, practiced and used in the DySim lab. When the field trip ended, Melissa Holmes, staff manager of the Oakland Air Route Traffic Control Center, extended a fond farewell, and students filed out the door still talking about all that they had seen and done.

 "With the Smart Skies education project and real-world events such as this one today, NASA and the FAA are taking math from the chalkboard and making it real to these students," said Davis.

The Sector 33 mobile game application may be downloaded free of charge at: *http://www.nasa.gov/sector33*
(POC: Rebecca Green)

Airspace Systems Technologies Featured in Aerospace America, April 2012

As part four in their series on Aircraft and the Environment, *Aerospace America* featured the research of NASA's Airspace Systems Program as its cover story in the April 2012 edition. The article entitled "Getting from Gate to Gate" discussed the technology and software that is being developed to improve the efficiency of aircraft departures, arrivals, cruise trajectories, and ground-based movement while maintaining safe distances between planes. Program and project managers were interviewed for this article including Aeronautics Research Mission Directorate Associate Administrator Jaiwon Shin. *Aerospace America* is a monthly publication of the American Institute for Aeronautics and Astronautics.

Read the article here:
http://www.aeronautics.nasa.gov/pdf/apr2012_getting_gate_to_gate.pdf
*(POC: Michael Braukus)*

ADS-B Collaboration, March 2012

NASA and the FAA recently agreed to extend NASA Langley employee John Koelling's temporary assignment to the FAA for one additional year. John will continue to provide expertise to accelerate the transition of the Automatic Dependent Surveillance-Broadcast (ADS-B) applications from research to development and implementation.
(POC: John Koelling)

Farley Receives 2011 AA Award, April 2012

Todd Farley, of NASA's Ames Research Center, was awarded the 2011 ARMD Associate Administrator Leadership and Management Excellence Award at an awards ceremony held in April at NASA Headquarters. Farley received the award for his leadership of the Efficient Descent Advisor (EDA) and 3D-Path Arrival Management (3D-PAM) research efforts and for guiding those efforts to a successful technology transition to the Federal Aviation Administration. Farley helped NASA and partners achieve understanding of goals and responsibilities, organized and mentored teams
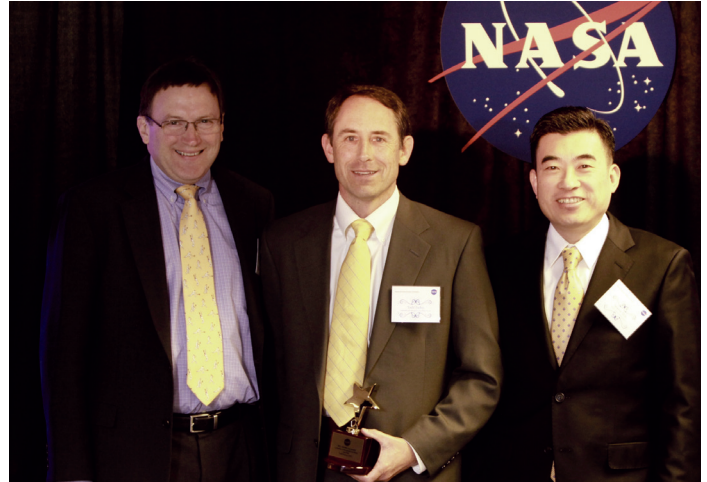
(l to r) ARMD Deputy Associate Administrator Tom Irvine, award recipient Todd Farley, ARMD Associate Administrator Jaiwon Shin.

to address requirements, and served as the primary interface between each of NASA's technical leads and the FAA's lead, overcoming many challenging management obstacles.

Read about Farley and the other 2011 AA Award recipients here:

http://www.aeronautics.nasa.gov/aa_awards.htm
(POC: Tom Davis)

National Aeronautics and Space Administration

Headquarters
300 E. Street, SW
Washington, DC 20024
www.aeronautics.nasa.gov

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