NASAfacts

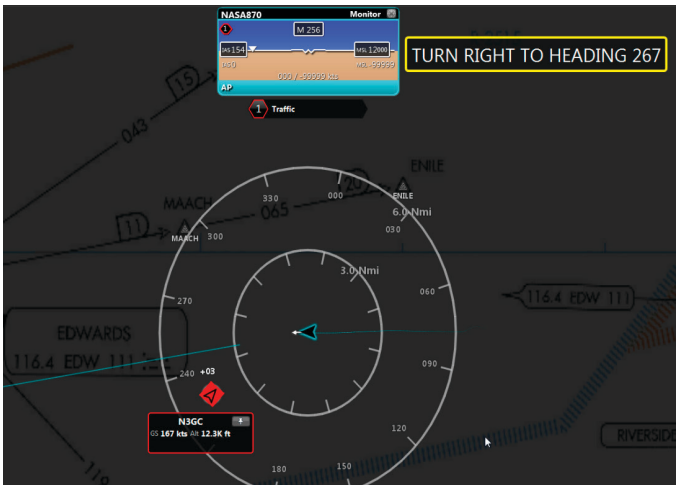
# Aviation Systems Division (Code AF) FY15 Technical Highlights

**Technology Transfer**
In May 2015, the Federal Aviation Administration (FAA) announced its final investment decision for full-scale implementation of NASA's Terminal Sequencing and Spacing (TSAS, formerly TSS) tools. NASA transferred the operational prototypes at Technology Readiness Level 6 to the FAA in 2014. These tools combine time-based arrival scheduling and display aids for air traffic controllers. TSAS allows use of fuel-efficient Area Navigation (RNAV) and Required Navigation Performance (RNP) arrival procedures in terminal airspace during the busiest traffic conditions. The increased use of Performance Based Navigation (PBN) procedures will reduce vectoring, require less level-offs at intermediate altitudes, and result in fewer verbal communications between controllers and pilots. The FAA plans to deploy TSAS to five busy airports – Phoenix Sky Harbor, Houston Intercontinental, Atlanta Hartsfield, Seattle-Tacoma, and Los Angeles – starting in 2018.

**Terminal Sequencing and Spacing (TSAS)**
The Operational Integration Assessment (OIA), completed in May 2015, was an FAA/NASA demonstration of the FAA's Ground-based Interval Management for Spacing (GIM-S) integrated with NASA's TSAS ground automation technology, which took place at the FAA's William J. Hughes Technical Center (WJHTC). The main objective of the OIA was to identify TSAS operational risks (including technical, policy, procedures, computer human interface, and training) that need to be addressed prior to transitioning TSAS from the laboratory to the National Airspace System (NAS). The OIA simulation was preceded by eight months of intensive simulation and experimentation to test simulation scenarios, including the off-nominal procedures of particular focus for the OIA, refine procedures and testing materials, explore baseline performance, and validate software and adaptation changes.

**Integrated Arrival, Departure, and Surface (IADS) Research**
In Oct. 2014, the Spot and Runway Departure Advisor (SARDA) research effort was completed and the Division directed its airport surface research towards Airspace Technology Demonstration-2 (ATD-2) objectives. Numerous workshops and technical meetings were held with multiple stakeholders to define the goals of ATD-2. ATD-2 aims to increase aircraft arrival, departure and surface movement predictability and efficiency in metroplex traffic environments by integrating and

The 2015 NASA/FAA Operational Integration Assessment (OIA) Team at the FAA Tech Center




Screenshot of the Detect and Avoid (DAA) System

leveraging FAA and industry technologies including collaborative decision making (CDM) capabilities, with state-of-the-art air traffic management scheduling technologies (including NASA's SARDA and Precision Departure Release Capability [PDRC]). The FAA views improving airport surface operations as a high priority, and the ATD-2 project was seen as a critical activity for addressing the NextGen Integration Working Group stakeholder recommendations for surface improvements. In July 2015, NASA Ames Research Center and several stakeholder organizations joined the FAA's Assistant Administrator for NextGen, Mr. Ed Bolton, to kick off collaboration on the ATD-2/Departure Metering effort at Charlotte Airport, which will serve as the test site for the initial ATD-2 demonstration of a NextGen departure metering capability consistent with the FAA's Surface CDM Concept of Operations.

**Unmanned Aircraft Systems in the National Airspace System (UAS in the NAS)**

The UAS in the NAS project executed numerous fast-time and real-time human-in-the-loop (HITL) experiments and flight tests, providing the research findings that will influence and create policies for national standards for UAS operating in domestic civilian airspace. The experiments included evaluating detect-and-avoid (DAA) displays and algorithms that aid UAS pilots in remaining "well clear" of all traffic. RTCA Special Committee-228 (SC-228) is charged with developing regulations that establish Minimum Operational Performance Standards (MOPS) for safe and routine operation of UAS in the NAS. In July 2015, the RTCA SC-228 released its draft MOPS, which included NASA's research findings from the Separation assurance/Sense and avoid/Interoperability (SSI) sub-project. The SSI team completed the most comprehensive study to date of aircraft-to-aircraft encounters, with a dataset that included 21 days of aircraft-to-aircraft encounters from approximately 20,000 UAS flights modeled per 24-hour period, and covered eighteen different UAS missions. The results establish the frequency with which a UAS DAA system may have to manage UAS well clear separation due to intruders, and also determine the types of encounter situations that may need to be mitigated, and their respective frequencies.

**Traffic Flow Management (TFM) and Weather Routing**

Division researchers contributed to subproject formulation on addressing TFM efficiency, including improved weather routing. This work included completing the testing of the Dynamic Weather Routes (DWR) system at American Airlines under an existing Space Act Agreement and initiating the development of follow-on capabilities for weather routing, including the National Airspace System Constraint Evaluation and Notification Tool (NASCENT, a NAS-based implementation of the DWR concept). DWR and NASCENT were demonstrated to other potential industry customers and partners including Sabre Airline Solutions and Federal Express.

The Optimized Route Capability (ORC) research area was initiated to address intelligent arrival meter fix offloading in the traffic management unit (TMU). ORC addresses the conditions where arrival gates or meter fixes serve as major bottlenecks for arrival traffic (as opposed to airport runway capacity). The NASA team is developing an algorithm to identify projected periods of meter fix overload and suggest individual flight reroutes (including both pre-departure and airborne flights) to alternate meter fixes, with a minimal increase in flight distance. Houston (TX) Intercontinental (IAH) was one facility envisioned to benefit from ORC technology. Division researchers are collaborating with FAA's WJHTC to plan and execute a prototype demonstration in March 2016.

**Air Transportation and the Environment**

In support of growing research into environmental impacts of aviation, Dr. Banavar Sridhar, Senior Scientist for Air Transportation Systems at NASA Ames, was a panelist at the Global Challenges to Improve Air Navigation Performance Workshop organized by the NEXTOR Consortium and the FAA in Feb. 2015. Dr. Sridhar also attended the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP) Environmental Impacts Seminar in the same month. As a member of the ICAO Impact and Science Group (ISG), Dr. Sridhar presented NASA's air traffic operations research designed to balance fuel efficiency and environmental impact. The group will also produce a new white paper on the impact of climate on aviation, summarizing the state of knowledge regarding climate change risk and resilience.

**Shadow Mode Assessment using Realistic Technologies for the National Airspace System (SMART-NAS) and SMART-NAS Test Bed**
The SMART-NAS project continued to develop the architecture and evaluate technologies for the SMART-NAS Test Bed (SNTB). Four NASA Research Announcement (NRA) teams, led by Boeing, Crown Consulting, Metron Aviation, and Robust Analytics and consisting of 13 organizations in total, shared their approaches to the SNTB architecture. The Division's SNTB team developed an initial distributed display capability using the Aircraft Situation Display to Industry (ASDI) live-data feed and Aircraft Simulation for Traffic Operations Research (ASTOR). The display is part of the platform infrastructure and takes advantage of operating on the NASA/Amazon cloud, to enable the display to be visible across the country. Currently, both ASDI and ASTOR run independently on the cloud, using Cesium (a free, open-source Web Graphics Library (WebGL) virtual globe and map engine) and Google Earth, respectively, as the display platforms. The SNTB will next integrate both systems into a single display.

**Data Management**
In June 2015, the Division kicked off a contract with ATAC Corp. to add new capabilities to the air traffic management (ATM) Data Warehouse (known as Sherlock) to greatly increase the ability of researchers to quickly analyze real track data from the entire NAS in a cleanly-fused format. The work will include real-time streaming of data to clients such as the SMART NAS Test Bed. The contract task will also include integration of Sherlock with ATAC's SkyView product, which is the commercial version of PDARS (the FAA's Performance Data Analysis and Reporting System), and is an analysis and reporting tool to examine everything from NAS performance to airspace design. The contract was awarded through SGT, Inc. and has a period of performance of one year.

**Unmanned Aerial System (UAS) Traffic Management (UTM)**
The NASA UTM project successfully completed its Build 1 Demonstration Aug. 24-Sep. 2, 2015 at Crows Landing Airfield in California. Numerous industry, academic, and government partners participated in the UTM demonstration with NASA Ames. Several objectives were accomplished during the flight test, including the demonstration of UTM capabilities/procedures, navigation performance, and aircraft tracking. Data were collected on noise signatures and observations for weather models. Analysis of the results is underway to help design future UTM flight tests.

**Conferences and Events, Technical Meetings**
The Division participated in numerous technical conferences in 2015, including the prestigious USA/Europe ATM Seminar, in Lisbon, Portugal. Of the nine NASA papers, three papers from NASA Ames were acknowledged as "best in track" at the conference. The Division's research was also honored with two best paper in track and best paper in session awards at the Oct. 2014 Digital Avionics Systems Conference (DASC) in Colorado Springs, Colorado.


Screenshot of the SMART-NAS Test Bed ASDI live data display

**Simulations**
The Division's Aerospace Simulation Research and Development Branch (SimLabs) continued to make contributions to the science of motion simulation as well as the research and development goals of NASA missions and outside customers. In Dec. 2014, SimLabs completed the second of three FAA-sponsored Motion Cueing experiments in the Vertical Motion Simulator (VMS) to develop objective hexapod system motion cueing parameters. The U.S. Congress has mandated that aircrews be trained in stall and upset recovery, which airlines accomplish using motion-based simulators. The motion cueing experiment developed a model of the pilot's combined motion and visual perception dynamics in the pitch/longitudinal and heave axes which can then be used to configure simulator motion cueing systems for stall and recovery training. SimLabs also executed a VMS experiment in support of understanding pilot loss of control, the leading cause of jet casualties worldwide.

**Collaborations**
Within NASA, the Division has been working regularly with the other Aeronautics Centers (Armstrong, Glenn, and Langley) in AOSP and UAS in the NAS research, and have begun interactions with the Jet Propulsion Laboratory. Other government partners include the Departments of Defense, Homeland Security, and Commerce; Lawrence Livermore National Laboratory's National Ignition Facility; and the FAA's Office of Environment and Energy and Collaborative Decision-

During Ames' "Open House," members of the public were invited to visit the Vertical Motion Simulator, where they could experience its high-fidelity out-the-window scene and flight instruments.

Aviation Systems Division staff participated in panel discussions during the three-day UAS Traffic Management (UTM) Convention held at NASA Ames Research Center in July.

Making; and FAA contractors including Lockheed Martin, Raytheon, and MITRE.

The Division also met with a number of current and potential international partners, including the Korea Agency for Infrastructure Technology Advancement (KAIA), the Korea Aerospace Research Institute (KARI), Incheon International Airport (ICN) Corporation, the Singapore Air Traffic Management Research Institute (ATMRI), the Office National d'Etudes et de Recheches Aerospatiales (ONERA) from France, International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP) Impact and Science Group (ISG), the Aeronautical Technology Directorate of the Japan Aerospace Exploration Agency (JAXA), Queensland University of Technology and Boeing Research and Technology of Australia, and the German Aerospace Center (DLR) in Braunschweig, Germany.

In academia, technical discussions were explored with the University of Texas at Arlington (UTA). Collaborations are ongoing with Stanford University, and the University of California at Berkeley and Santa Cruz, and San Jose State University.

**Publicity**

During the fiscal year, the Division had several opportunities to showcase the Agency's work. Division researchers participated in NASA Ames' "Open House" in Oct. 2014, which welcomed members of the public to experience the Division's VMS and FFC, and engage in discussions with experts on air traffic and simulation research. In July 2015, the Division participated in the UAS Traffic Management (UTM) Convention held at Ames, which brought together a broad international and U.S. audience. Staff provided demos and participated in panel discussions during the three-day event. Division work was featured in articles by major media outlets, including the Washington Post, Aviation Week, and BBC Future.

**Personnel**

In Dec. 2014, the AF Division welcomed a new Division Chief, Ms. Sandy Lozito. Sandy most recently served as the branch chief of the Aerospace High Density Operations branch (code AFH) for four years, and has been a NASA researcher in the field of aeronautical human factors for over twenty years. Sandy is also currently a member of the planning committee for the FAA/Eurocontrol Air Traffic Management Seminar.

In Sep. 2015, the Division sadly lost a long-time employee, Dr. Vernon J. Rossow. Dr. Rossow joined the National Advisory Committee on Aeronautics (NACA) in 1949, and worked for NACA/NASA until 2005 when he officially retired from government service. However, in his remaining years, Dr. Rossow continued to serve as an Ames Associate, continuing research on fluid mechanics and aerodynamics, and was the local expert on wake vortices. We will miss Vern's dedication, kindness, and gentle good humor.

**More Information**

For more information about the Aviation Systems Division, please visit:

***www.aviationsystems.arc.nasa.gov***

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