



# AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

APR-JUN 2022 | Quarter 3



ATD-2 Selected for the 2022 World ATM Congress Sustainability Maverick 3

SWS Presents IASMS Concept at Business Safety Summit Panel 13

## AOSP IN THE NEWS

### [Citing Safety Concerns, Whistleblowers Urge Revamp of Aging Boeing 737 MAX Cockpit](#)

Seattle Times (4/19) reports “Last month, two prominent flight control experts and whistleblowers — one ex-Boeing, one ex-FAA — delivered to the U.S. Senate committee overseeing aviation a technical proposal to upgrade Boeing’s 737 MAX cockpit to current design standards. ... A 2019 NASA report written by Randy Mumaw, a former senior Boeing human factors specialist, analyzed 18 in-flight accidents where pilots lost control of older aircraft, one-third of them 737s, and identified a pilot-alerting failure in every case.”

### [Joby: Results of Noise Tests Show Aircraft Would Be Quiet Enough for Cities](#)

Aerospace America (5/10) reports “Joby Aviation’s noise tests with NASA in August and September demonstrated that the company’s prototype electric passenger aircraft, the S4, met the company’s own sound level standards, Joby said today in a news release.”

### [Joby: NASA Tests Confirm eVTOL’s Low Noise](#)

Aviation Week (5/19) reports “Acoustic testing completed with NASA last year confirmed the low noise profile of Joby Aviation’s tilt-prop electric vertical takeoff and landing air taxi, the startup said May 10.”

### [NASA Mulls Data Ecosystem to Help Drones, Air Taxis Make Critical Safety Decisions](#)

DroneDJ (5/24) reports “we’re working toward a future where passenger air taxis and drone deliveries are to become a part of everyday mobility. But how will these autonomous systems access important information, such as deteriorating weather conditions, to complete each flight safely?”

### [NASA Mulls Data Ecosystem to Help Drones, Air Taxis Make Critical Safety Decisions](#)

Space Daily (5/25) reports “in cities like Los Angeles or Atlanta, traffic often determines how early we wake up to travel to work, what time we plan to meet friends for dinner, or how long it will take to get to the airport. For trips between cities, a road trip to a relative’s house could take anywhere from four to six hours. NASA’s Advanced Air Mobility (AAM) mission is researching how the addition of AAM could cut traffic commutes, make travel more sustainable, and make road trips shorter.”

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

### **ATD-2 Selected for the 2022 World ATM Congress Sustainability Maverick Award**

POC: [SHAWN ENGELLAND](#)

In late June, the Air Traffic Control Association and the Civil Air Navigation Services Organization, as partners in The World Air Traffic Management (ATM) Congress, have awarded the Sustainability Maverick Award to NASA's Airspace Technology Demonstration-2 (ATD-2) project. The Sustainability Award recognizes leaders, initiatives, and organizations working toward reducing aviation's impact on the environment and making significant contributions to improving the environmental footprint of aviation through ATM.

“This year's winner is NASA Ames Research Center. NASA's Airspace Technology Demonstration 2 (ATD-2) was a four-year (Sept. 2017 – Sept. 2021) field demonstration of Integrated Arrival/Departure/Surface (IADS) technologies designed to improve the predictability and efficiency of surface and departure operations. The Federal Aviation Administration (FAA) is in the process of implementing Terminal Flight Data Manager (TFDM) at 89 airports, of which 27 will have the advanced surface departure metering and overhead stream insertion capabilities demonstrated by ATD-2. ATD-2 validated the TFDM concept, provided knowledge and technology to

the FAA and Industry, and demonstrated benefits that exceeded FAA projections for TFDM. During the four-year demonstration at Charlotte Douglas International Airport (CLT), ATD-2 saved more than 1.1 million gallons of fuel and 11,600 tons of CO<sub>2</sub>. The FAA projects annual CO<sub>2</sub> savings of 75,000 tons when TFDM is fully implemented.”

### **ATM-X xTM Engages with the USTRANSCOM and AFRL Rocket Cargo Team**

POC: [DAVID MURAKAMI](#)

On April 1, the Air Traffic Management – Exploration (ATM-X) project's Extensible Traffic Management (xTM) subproject Space Launch and Recovery Traffic Management (SLRTM) team met with the U.S. Transportation Command (USTRANSCOM) and the Air Force Research Laboratory (AFRL) Rocket Cargo team to exchange information. The xTM SLRTM team described NASA's research on the potential use of an xTM system for managing space launch and recovery traffic and the USTRANSCOM/AFRL team gave a briefing on exploring rocket cargo transportation capability for Department of Defense logistics (<https://afresearchlab.com/technology/successstories/rocket-cargo-for-agile-global-logistics/>). This initial information exchange generated a consensus that a new way of managing rocket launch and

recovery traffic would be necessary for handling rapid rocket cargo operations and coordinating with commercial airspace operations. The meeting resulted in the Rocket Cargo team proposing that NASA participate and witness their launch process training or an actual launch targeted for 2026. The NASA SLRTM team was also added to their weekly tabletop exercise preparation meeting. Both teams are planning to continue engagement.

### **AOSP Projects Attend RTCA Quarterly Meeting**

POC: [TOD LEWIS](#), [STEVE YOUNG](#), AND [EVAN DILL](#)

From April 4–7, the Air Traffic Management – Exploration (ATM-X) and System-Wide Safety (SWS) projects virtually attended and participated in the RTCA SC-228 quarterly meeting that took place in Washington, DC. Representing the ATM-X project, the Pathfinding for Airspace with Autonomous Vehicles subproject members provided input to the Unmanned Aircraft Lost Command and Control Link Guidance Material document under development by Work Group 3 (WG3). WG3 is developing guidance on Unmanned Aircraft System (UAS) lost link procedures and automation. The SWS team is also participating in WG3 and is leading the Verification and Validation section. Additionally, in support of Working Group 4, which is developing guidance on

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

navigation gaps for UAS, the SWS team has reviewed and submitted comments on the current draft.

### **SWS and FAA Hold Joint Technical Interchange Meeting**

POC: [KYLE ELLIS](#)

From April 6-7, the System-Wide Safety (SWS) project hosted a Joint NASA/FAA Technical Interchange Meeting. The first day's theme was "In-Time Aviation Safety Management System (IASMS) - What is it?" Agenda items included the presentations "Research Transition Team (RTT)" and "IASMS Concept of Operations (ConOps) Working Group (WG)" by Kyle Ellis of NASA and Rick Pittaway of the FAA; "In-Time Aviation Safety Management Systems Concept Overview" by Kyle Ellis; "NASA programmatic overview for IASMS" by Jessica Nowinski of NASA; and "FAA Research Overview" by Mark Orr of the FAA. A "Digital Co-Pilot" presentation was provided by Cory Stephens of the FAA, and future joint work on IASMS and SMS by Kyle Ellis and Rick Pittaway. "Data Analysis and Prediction Data" was the theme on April 7, with topics covering "Introduction to SWS RTT and Data WG" by Nikunj Oza of NASA and Aleta Best of the FAA; "ASPIRE (Analyze Safety Performance Insight

Results Environment Tool)" by Tom Stafford of the FAA; "Machine Learning/Artificial Intelligence (ML/AI) Anomaly Detection" by Bryan Matthews of NASA; "Monitoring Airspace Safety with RACE Tool" by Peter Mehlitz of NASA; and "Safety Investigation Toolkit for Analysis and Reporting (SITAR)" by Dan Pearce of the FAA.

### **ATM-X DIP Team Visits NASA's Langley Research Center**

POC: [MIRNA JOHNSON](#)

On April 11, the Air Traffic Management – Exploration (ATM-X) project's Digital Information Platform (DIP) subproject team members met at NASA's Langley Research Center in Virginia for a day of training and team building. Familiarization of flight deck operations and air traffic control training started with a two-and-a-half hour briefing and open discussions with an experienced commercial aircraft pilot and an air traffic controller. Each team member experienced the Boeing 737-800 Cockpit Motion Facility simulator session to understand the various flight deck technologies. During the visit, attendees observed flight deck management technologies in development at the center and were given a tour of the Flight Simulation Facilities Laboratory and the Air

Traffic Operations Lab. Familiarity with the simulation facilities will help the team prepare development plans for DIP's Sustainable Aviation Demonstration-2 (SA-2) planned for fiscal year 2026. The visit provided team members working across multiple centers a chance to meet and foster greater connectivity and communications.

### **SWS and FSF Closeout Workshop Series for IASMS Roadmap**

POC: [MICHAEL VINCENT](#)

From April 13-14, the System-Wide Safety (SWS) project, in collaboration with the Flight Safety Foundation (FSF), held the final two of a series of workshops to elicit inputs from aviation safety subject matter experts (SMEs) to help build a long-term roadmap for In-Time Aviation Safety Management System (IASMS). The workshops consisted of moderated discussions regarding safety risks and uncertainties of emerging aviation operations as well as potential strengths, weaknesses, opportunities, and threats of the technologies that will enable those operations. The roadmap will eventually help guide the development, deployment, and assurance of emerging aviation operations such as those being researched by NASA's Advanced

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

Air Mobility, SWS, and Air Traffic Management – Exploration projects. A wide range of topics were covered across the workshops, including cybersecurity, autonomy, disruptions, regulatory framework, safety culture, and public education. Researchers and SMEs across NASA participated in the workshops. The output of the workshops will be compiled into a full report on the IASMS roadmap before being socialized with industry and stakeholder partners.

### **NASA/FAA Laboratory Integrated Test Environment Accreditation II**

POC: [NELSON GUERREIRO](#)

NASA and the FAA have achieved a second key milestone in their Interagency Agreement to collaborate on Advanced Air Mobility (AAM) research. On April 19, the Air Traffic Operations Lab at NASA's Langley Research Center in Virginia and the FAA's William J. Hughes Technical Center's laboratories successfully executed a test of the latest enhancements to laboratory integrated capabilities that demonstrate AAM operations in the Atlantic City area. The milestone achieved was an accreditation test validating the functionality of the associated integrated systems and is a formal

process developed by the FAA to validate systems interoperations with a partner's external systems. The NASA/FAA Laboratory Integrated Test Environment (NFLITE) activity brings together NASA prototype systems for AAM and FAA operational systems to support research in the areas of concept validation and human and machine systems integration, among others. NASA's prototype capabilities used in the initial integration and accreditation included the Urban Air Mobility (UAM) Vehicle Simulation, Mission Planner, Vertiport Scheduler, and the Advanced Trajectory Services - Toolkit for Integrated Ground and Air Research capability. The FAA's capabilities included the Target Generation Facility, Simlab and ScanEagle Unmanned Aircraft Systems simulations, a virtual tower view, and the Standard Terminal Automation Replacement System. The latest enhancements to NFLITE included the addition of two fixed-base simulation capabilities from the FAA's Cockpit Simulation Facility as well as modifications to NASA's existing capabilities. A Sikorsky S-76 piloted simulator performed medical transport missions in Atlantic City while a Cessna 172 piloted simulator performed general aviation operations in the same airspace. The NFLITE capability

is an innovative and unique research capability that serves as the launching point for a multiyear portfolio of research activities between NASA and the FAA to better identify, understand, and validate airspace requirements to support UAM and AAM operations. This activity is supported by the Air Traffic Management – Exploration project's UAM subproject.

### **AAM/HDV/AOA Flight Testing Completed**

POC: [JEFF HOMOLA](#)

The Advanced Air Mobility (AAM) project's High Density Vertiplex (HDV) subproject successfully completed flight testing and data collection as part of its Advanced Onboard Automation (AOA) work package with several notable accomplishments. On April 21, the AOA flight test team, which includes a large majority of the



*Picture shows the arrival of the three-vehicle operations with the third vehicle on approach.*

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

HDV project team at NASA's Ames Research Center in California and Langley Research Center in Virginia, performed three simultaneous vehicle operations fully integrated with Fleet Management/Provider of Services to Urban Air Mobility systems and additional simulated traffic. HDV personnel were present at NASA Langley's City Environment Range Testing for Autonomous Integrated Navigation and Remote Operations for Autonomous Missions lab and at NASA Ames's Airspace Operations Laboratory and Autonomous Vehicle

Applications Laboratory. In addition to the three-vehicle operations, the AOA flight test team also collected data from two more Ground Control Station Operator participants.

### **NASA Issues Public Release Highlighting SBIR-funded SWS/HATS Partnership**

POC: [MISTY DAVIES](#) AND [ERSIN ANCEL](#)

On Earth Day (April 22), NASA issued a public release that highlights a Small Business Innovation Research (SBIR) funded partnership between

NASA's System-Wide Safety (SWS) project and Human Automation Teaming Solutions, Inc. (HATS). HATS is using safety-related algorithms, data, and risk calculations that SWS has been prototyping for the In-Time Aviation Safety Management System (IASMS). The IASMS capabilities enable HATS to refine and commercialize automated drones and rovers that assess methane emissions at a landfill and provide real-time data to landfill ground control stations. For more information, please see <https://www.>



*HATS using SWS tools for automated drones and rovers to assess methane emissions at a landfill.*

# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

[nasa.gov/feature/nasa-technology-to-lower-landfill-methane-emissions](https://nasa.gov/feature/nasa-technology-to-lower-landfill-methane-emissions).

## Pilot Evaluation of eVTOL Detect and Avoid Performance Completed

POC: [CONRAD RORIE](#)

Last week, the Advanced Air Mobility project's Automated Flight and Contingency Management (AFCM) subproject completed simulation testing in the Human Automation Teaming Lab at NASA's Ames Research Center in California. The simulation was conducted by AFCM's Hazard Perception and Avoidance research team. The purpose of the study was to evaluate an FAA prototype implementation of Airborne Collision Avoidance System for rotorcraft Detect and Avoid (DAA) in application to electric vertical take-off and landing (eVTOL) aircraft with pilot feedback on the prototyped displays and coupled automation. Overall, 12 pilots participated in the study. This work supports the development of minimum operational performance standards for DAA systems used in rotorcraft including eVTOLs for safe distancing with collision avoidance for emergency situations. The next phase of testing for this work will be conducted in the Vertical Motion Simulator at NASA Ames in August to continue the evaluation of system-

recommended response maneuvers with motion present.

## SWS TC-2 Develops and Releases New NASA Technology for Fault Isolation

POC: [CHETAN KULKARNI](#) AND [MATTEO CORBETTA](#)

System-Wide Safety (SWS) project researchers Chetan Kulkarni and Matteo Corbetta have developed and released new technology and software through the NASA Technology Transfer Program to increase safety for electric propulsion vehicles. This technology utilizes a fault isolation approach that integrates Failure Mode and Effect Analysis (FMEA) and Bayesian Networks to diagnose electric powertrains of Unmanned Aerial Vehicles (UAVs)/Urban Air Mobility (UAM) vehicles. The new framework improves on existing fault detection and isolation to identify the root causes, effects, and severities of hazards by embedding the system FMEA developed during the design stage into Bayesian Networks that include sensor signals at their nodes. Diagnostic tools and design considerations are combined by integrating component age, usage rate, component specifications, and uncertainties when estimating health and remaining useful life of the component(s) under distress. Based on these factors, the likelihood

of each component's failure can be ranked according to a priori knowledge from the FMEA, and the likelihood of system failure is updated during the life of the component or subsystem to inform response to faults. Although developed specifically for electric UAVs/UAM vehicles, the same methodology is applicable to other domains, including manufacturing facilities and autonomous vehicles. A provisional patent application for the technology development has been filed.

## UAM Holds NASA/FAA Virtual Sessions to Review UAM Airspace Research Roadmap

POC: [KEVIN WITZBERGER](#)

In April 2022, the Air Traffic Management – Exploration project's Urban Air Mobility (UAM) Airspace Management subproject released a version of its UAM Airspace Research Roadmap, which will guide NASA's UAM airspace research and development during the next 10 years, for a broad review and comment by NASA and FAA subject matter experts. The document was reviewed and commented on by multiple FAA lines of business, including Air Traffic Organization, Mission Support Services, Air Traffic Services, the UAS Integration

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

Research office, and the Office of NextGen. In response to this review, approximately 600 comments were received. From April 26–27, the UAM principal engineer led two virtual sessions at the NASA Aeronautics Research Institute (NARI) to discuss and resolve some of the most significant of the comments received. The complexity of UAM airspace, and its progression from the as-is National Airspace System of today to the end-state system envisioned for UAM and the Advanced Air Mobility mission, is a highly complex engineering problem further complicated by the immature nature of the associated research and development. There is a need to effectively organize, integrate, and communicate NASA’s research and development in this area. To this end, the UAM subproject team has been developing the UAM Airspace Research Roadmap, which is an artifact used to interface UAM airspace stakeholders with the system engineering underpinning the UAM subproject’s research in this area. It begins with a hierarchical decomposition of the UAM Airspace System into capabilities and functions providing an accessible means of focusing attention to specific parts of the system while maintaining an understanding of the overall enterprise. It then examines how

those functions may evolve from today’s as-is National Airspace System through three evolutionary changes – the final stage being one in which the airspace user takes full responsibility for conflict management. The comments received will be used to greatly improve the quality and consistency of the content. Then, an interim version will be released to industry this summer. Following up on this, a series of NARI-hosted discussions with industry are being planned. A final baseline version (version 2.0) is expected to be published in December 2022, which will then be maintained as the UAM subproject executes its research and development plan to evolve the UAM airspace toward UAM Maturity Level-4.

### **ATM-X DIP’s University Challenge Submission Closed**

POC: [MIRNA JOHNSON](#)

The Air Traffic Management – Exploration (ATM-X) project’s Digital Information Platform (DIP) subproject is focused on creating a common platform to enable advanced data-driven services across the National Airspace System (NAS). These services will be able to build on each other, with each new service taking advantage of intelligence provided by existing services. One foundational service in DIP predicts

the configuration of airports (i.e., which runways are assigned for arrivals or departures). The DIP team has collaborated with the NASA Tournament Lab and contracted with DrivenData to run a competition among university teams to use machine learning to make these predictions. Each team was given access to one year of historical NAS data and asked to use it to make predictions about future airport configurations. The submission period of the challenge concluded on April 25, with 12 teams having made submissions before the deadline and a total of 380 participants who expressed interest in the topic. The DIP team and DrivenData are now in the process of gathering a dataset for final evaluation of the submissions to determine winners. The winning submissions will inform future work on DIP and the unique techniques used will potentially be incorporated into the platform.

### **ATM-X “Sky for All” Completes Exploratory Virtual Workshops**

POC: [SHAWN ENGELLAND](#)

The Air Traffic Management – Exploration (ATM-X) “Sky for All” activity, a community co-developed vision that will guide NASA and FAA research and development investment decisions for years to come, recently completed a series of 10 exploratory session



# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

interactive virtual workshops to guide the vision for the mid-21st century future aviation system. Following the Sky for All workshops completed last quarter (Greener Aviation on March 21; Future of Freight on March 24; Relief from Above on March 25; and Urban Air Travel on March 31), the team led the Flight from New Heights workshop on April 11. The team also led workshops for each vision capability, including Digital Flight, Digital Airspace and Communications, Navigation and Surveillance on April 1; Data and Decision Support Marketplace and Micro-services for Operators on April 4; Intelligent and Adaptive Automation on April 6; Systems of Systems Architecture and Methods on April 7; and a mini workshop on In-Time System-Wide Safety Assurance with the Flight Safety Foundation on April 26. Diverse stakeholders from the aviation industry, including flight operators, service providers, manufacturers, aviation and standards organizations, government, and the public were in attendance. Each workshop was an opportunity to drive collaborative discussions that will help NASA shape the principles and aspirations, capabilities, opportunities, use cases, barriers, and research questions that will put NASA on the path toward a sustainable, safe, resilient, and adaptable shared airspace.

## **ATM-X DIP Begins SA-1a Demo Data Collection**

POC: [MIRNA JOHNSON](#)

On April 28, the Air Traffic Management – Exploration (ATM-X) project’s Digital Information Platform (DIP) subproject began data collection for the Sustainable Aviation Demonstration (SA-1) “Data Platform to Enable Efficient Collaborative Departures Re-Routes (CDDR)” in collaboration with Southwest Airlines and American Airlines in the Dallas-Fort Worth airspace. This first phase of SA-1, called SA-1a, aims to apply machine learning techniques to airspace management data to allow airlines to fly along more efficient departure routes using service-oriented NASA airspace technologies. In its first days of data collection, the CDDR digital service identified a Trajectory Option Set route that was 35.9 nautical miles shorter than the filed route, saving the flight 4.7 minutes getting into the destination. The environmental benefits included 162 kilograms of fuel savings and 498 kilograms of carbon dioxide savings equivalent to 8.2 urban trees. This first phase will end in fiscal year (FY) 2023 with a cloud-based infrastructure to enable smaller footprint deployments followed by a second phase, called

SA-1b, which will end in FY 2024 with efficient operations in a more complex airspace. This second phase will deploy a DIP with improved access to the data and NASA-developed airspace management services to validate scalability of benefits across the National Airspace System.

## **SWS Collaborates with Lone Star UAS Test Site to Verify Navigation Quality Predictors**

POC: [STEVE YOUNG](#) AND [EVAN DILL](#)

From April 18–29, System-Wide Safety (SWS) project researchers collaborated with the Lone Star Unmanned Aircraft Systems (UAS) Test Site to experimentally verify navigation quality predictors as flight and surface tests were conducted in downtown Corpus Christi to collect Global Positioning System (GPS) data in an urban environment. These tests included a myriad of data collection scenarios that generated the measurements necessary to evaluate the developed Navigation Quality service, which is designed to predict the quality of GPS within a given four-dimensional volume. These flights represented the most extensive testing to date to evaluate the correctness and accuracy of the employed predictive models for this service.

# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

## SWS Researcher Participates in SAE S-18 Committee Meeting

POC: [MALLORY GRAYDON](#) AND [MISTY DAVIES](#)

On Feb. 17, representatives from NASA's Air Traffic Management-eXploration (ATM-X) project held a technical interchange meeting (TIM) with staff from the FAA's William J. Hughes Technical Center to discuss related work and collaboration opportunities for the integration of increasingly autonomous aircraft in airspace shared with conventional aircraft. An overview of the ATM-X Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject was presented, and touchpoints were identified.

## ETM Partner and FAA Publishes Cooperative Operation in Higher Airspace Proposal

POC: [YOON JUNG](#)

In April 2022, in partnership with NASA and the FAA's Upper Class E Traffic Management (ETM) team, the Aerospace Industries Association (AIA) published a proposal titled "Cooperative Operations in Higher Airspace." The proposal captures NASA's leadership-enabling cooperative operations through Unmanned Aircraft Systems Traffic Management-like service-

oriented architecture – facilitating necessary information exchanges for cooperation and conflict resolution. The proposal also showcases the impact of the Air Traffic Management – Exploration (ATM-X) project's Extensible Traffic Management (xTM)/ETM team's research for conflict identification among aircraft with vastly different performance characteristics ranging from free-flying balloons and slow-flying solar-powered High-Altitude Long Endurance aircraft to supersonic aircraft. AIA and high-altitude operator communities are looking to continue the partnership with NASA and the FAA's ETM work and the ATM-X/xTM/ETM team is addressing the need with algorithm development, rapid prototyping, and collaborative evaluation of a prototype NASA research ETM system with industry and the FAA. The first of the ETM collaborative evaluations is scheduled for summer 2023. To view the proposal, [visit this site](#).

## HDV Conducts UAM Ecosystem Review

POC: [JEFF HOMOLA](#)

After successful completion of simulation and flight testing as part of its Advanced Onboard Automation (AOA) work package, the Advanced Air Mobility project's High Density Vertiplex (HDV) subproject held a

formal Urban Air Mobility (UAM) Ecosystem Review during the week of May 2. The purpose of this event was to review the foundational concepts, systems, and research approach as implemented in AOA to ensure alignment and preparedness as the team moves forward with its plans for the next work package: Scalable Autonomous Operations. A review panel was in place including multicenter representation with additional stakeholders and subject matter experts in attendance. Formal feedback was requested of the review panel with responses due by May 13.

## xTM Briefed on ETM Market Modeling

POC: [JAEWOO JUNG](#)

The Air Traffic Management – Exploration project's Extensible Traffic Management (xTM) subproject hosted a briefing with LMI on May 2. LMI was tasked in fiscal year 2021 to: 1) elicit knowledge and information to understand the current and future opportunities associated with operations at high altitudes and the risks and barriers to realizing those opportunities and 2) estimate the difference in the high-altitude operations market size with and without Upper Class E Traffic Management (ETM). The LMI team recently completed the knowledge elicitation and developed a prototype model of the ETM

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

market. Their briefing included a live demonstration of the prototype model. The scope of the prototype for the demonstration was limited to a single use case where a fleet of High-Altitude Long Endurance (HALE) fixed-wing aircraft provided broadband internet services to households without access to terrestrial fixed-broadband internet service, such as Dixie County in Florida. According to the Federal Communications Commission, 74 percent of households in Dixie County do not have access to broadband and less than one percent have 50 mbps or better service. The model illustrated the change in the market size when ETM is in place, allowing 10 HALE aircraft to stay above Dixie County for the broadband service versus without ETM, where only one HALE aircraft can stay above due to the altitude reservation system currently in place. The LMI team is working to enhance the prototype model to include additional use cases and vehicle types and is scheduled to deliver the final market model with the user manual by September 2022.

### DIP Holds TIMs with SWS and DRF Teams

POC: [MIRNA JOHNSON](#)

This past quarter, the Air Traffic Management – Exploration project’s Digital Information Platform (DIP)

subproject team held multiple Technical Interchange Meetings (TIMs) with other NASA projects. On April 15, the DIP team held a TIM with the System-Wide Safety (SWS) project. SWS is developing an array of services requiring digital National Airspace System (NAS) information. The DIP team presented its technical approach for sharing NAS information from Fuser as well as prediction information from machine learning-based services. There was mutual interest to connect SWS to DIP to access this information and support services development and eventually register SWS-developed services for evaluation on the platform.

On May 5, the team held a TIM with the Convergent Aeronautics Solution project’s Data Reasoning Fabric (DRF) team. The DRF team is exploring a data and reasoning exchange among many systems interacting in complex and dense airspace with an emphasis on Advanced Air Mobility’s emerging operations. Some of the core functionality needed in DIP is also needed in DRF, which presents an opportunity for both teams to hold TIMs to cover various topics throughout the design and demonstration phases. This TIM focused on the common requirements for authentication and authorization and how it can be applied in a decentralized solution. Results and

outcomes from the demonstrations will be shared between the two projects to ensure effective advancement in data and services marketplace for the community.

### xTM/ETM Team Hold Meetings with Stakeholders

POC: [JAEWOO JUNG](#) AND [MIN XUE](#)

The Air Traffic Management – Exploration (ATM-X) project’s Extensible Traffic Management (xTM) subproject team held several meetings with stakeholders this past quarter. On May 6, they met with representatives from the FAA and industry. The xTM’s Upper Class E Traffic Management (ETM) team participated in the meeting and shared information regarding their recent flight tests and upcoming activities. The group continued the discussions on ETM with topics such as the current use of telephone and VHF radios for the communications between ETM operators and Air Route Traffic Control Center and air traffic control (ATC) – including an envisioned future of these communications through Voice over Internet Protocol and data link. NASA’s ETM team briefed the group about NASA’s airspace operations simulations capabilities, as well as the recently released ATC interactions survey to better understand current operating procedures and communications with ATC. Inputs

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

gathered through the survey will be used to identify best practices, possible future challenges to scaling these practices, and potential ATC workload issues associated with the scaling. The group is planning to meet again to discuss cooperative operations and use cases for building scenarios for a collaborative evaluation of a prototype ETM system scheduled sometime during summer 2023.

On May 10, the ETM team, along with members of the FAA's ETM Research Transition Team, conducted a meeting with an engineering team from Raven Aerostar – which provides cellular connectivity and remote sensing capabilities from the stratosphere using their Thunderhead Balloon System. Raven Aerostar has been recognized as the successor to the previous Loon LLC. The NASA ETM team shared their current research and development progress and vision for upper Class E airspace management and invited Raven to future industry tag-up meetings. Raven's team briefed their current balloon operation status and introduced their web-based platform for tracking and operating balloons. Raven's team also shared the information and mechanism they are using to communicate with Air Navigation Service Providers for their balloon operations including the calculated flight plans. This meeting allowed for exchange of information on current upper Class

E operations and research required to enable future coordinated operations across the different mission types. Continuing discussions are planned to further coordinate and develop potential plans for examining the integration of these stratospheric flights into the envisioned ETM system.

### **SWS Project Signs Multiple SAAs This Quarter**

POC: [MISTY DAVIES](#), [EVAN DILL](#), AND [KYLE ELLIS](#)

The System-Wide Safety (SWS) project signed off on three separate Space Act Agreements (SAAs) this past quarter. On April 20, the SWS project executed an SAA with Airborne International Response Team (AIRT)/DRONERESPONDERS to conduct collaborative research and development of automated safety processes and procedures to enable highly automated aviation response in the national airspace. AIRT/DRONERESPONDERS is a global network of specialized teams of subject matter experts in disciplines including aviation, emergency management, and public safety. These teams are trained and skilled to accomplish mission-critical tasks across the preparedness, mitigation, response, and recovery phases of significant events, complex emergencies, and major disasters. The agreement will allow DRONERESPONDERS to share operational expertise and data obtained from a broad variety of emergency response

activities in the National Airspace System with NASA. SWS project researchers, together with DRONERESPONDERS, will use this data collection and analysis to develop and implement a safety management system enabling highly automated flights for emergency response operations, as well as to develop an effective and robust demonstration of highly automated aerospace vehicle safety management systems that have applicability for aviation operations beyond emergency response situations.

In early May, a second SAA was signed with Longbow Corporation's Unmanned Aircraft Systems Operations to collaboratively test and evaluate prognostic services, functions, and capabilities (SFCs) developed under the SWS project. Longbow will utilize the capabilities of NASA developed prognostic SFCs (e.g., Global Navigation Satellite System performance monitor, population density risk assessment, battery health monitor, etc.) during flight operations to increase situational awareness and decrease exposure to hazards. NASA, in turn, will receive valuable data from the Longbow's operations and feedback on the utility of their developed SFCs. This will allow SWS to better refine the prognostic SFCs being developed.

On May 11, the SWS project signed a SAA annex with the Ohio Department of Transportation (ODOT).

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

The umbrella SAA with ODOT was established under the Announcement of Collaborative Opportunities for NASA's Advanced Air Mobility (AAM) National Campaign. This second annex has been established by the SWS project to support development and test of its In-Time Aviation Safety Management System (IASMS) – an interconnected set of key safety technologies to manage risk and assure safety. ODOT has developed a leading national ecosystem of industry partners along with a set of use cases in support of their state economic development plan. This collaborative effort with ODOT will mature IASMS technologies and capture key flight data necessary to inform new guidance, standards, and regulations. Updates and establishment of new guidance and standards are necessary to transform the national airspace system to safely integrate new entrant operations envisioned under AAM and NASA's "Sky for All" vision for 2045.

### **SWS Presents IASMS Concept at Business Aviation Safety Summit Panel**

POC: [KYLE ELLIS](#)

Kyle Ellis, deputy project manager for NASA's System-Wide Safety (SWS) project, was invited to present NASA's In-Time Aviation Safety Management System (IASMS) concept at the 67th Annual Safety Summit in Savannah, Georgia on

May 11. Organized by the Flight Safety Foundation in partnership with the National Business Aviation Association (NBAA), the summit covers safety, training, practical solutions, management, human factors, and other issues for every segment of the business aviation industry. This interaction is important as it engaged nearly 200 existing Part 135 and 91 operators and organizations such as Air Charter Safety Foundation and NBAA – key stakeholders whose input is critical to future development of concepts for airspace management and safety of highly diverse and complex operations currently flying in the National Airspace System (NAS). Currently, less than two percent of all Part 135 operators have a formally recognized SMS program – and even fewer for Part 91 operators – largely in part to lack of requirements and guidance for implementation of a safety management system program, and limited availability of effective scalable and tailorable safety technologies to make it effective and economical. The concept of IASMS as a set of scalable and tailorable safety services was very well received and further collaboration between NASA and key industry partners is currently being investigated as a result of this engagement. These collaborations are essential to future development and implementation of concepts like IASMS to be effective across all operational domains and

assure safe operations in a transformed NAS.

### **DIP Team Attends MR-TBO Phase 2A Lab Demo by FAA and Partners**

POC: [MIRNA JOHNSON](#)

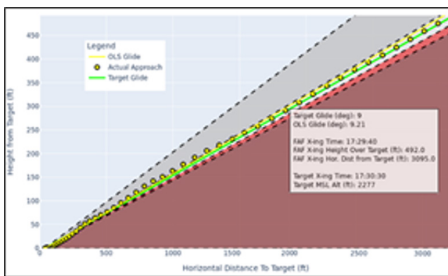
The Air Traffic Management – Exploration (ATM-X) project's Digital Information Platform (DIP) subproject team attended a lab demonstration on Multi-Regional Trajectory Based Operations (MR-TBO) Project Phase 2A hosted by the FAA and the International Civil Aviation Organization partners at the FAA Test Bed in Daytona Beach, Florida from May 11-12. The lab demonstration integrated scenarios with multiple partners including NAVCanada, AEROTHAI, Civil Aviation Authority of Singapore, and Japan Civil Aviation Bureau. The demonstration consisted of five end-to-end scenarios between partners to demonstrate Trajectory Based Operations capabilities and operational values including Alignment of Strategic Plan and Tactical Actions, pre- and post-departure negotiations with multiple airline service providers, and flight data sharing using Flow Information Exchange Model, flight deck collaboration through Electronic Flight Bag capabilities, and many others.

# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

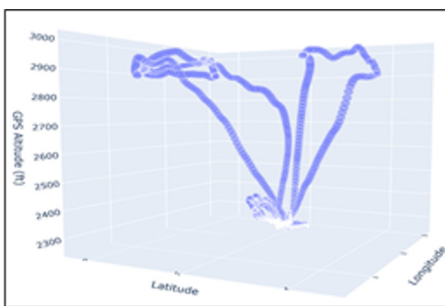
## AAM National Campaign ATI hosts “Aerograph Architecture” Tech Talk

POC: [DIVYA BHADORIA](#)

On May 13, the Advanced Air Mobility (AAM) project’s National Campaign (NC) subproject’s Airspace Testing and Integration (ATI) team hosted a technical talk to an audience consisting of NASA researchers from across the agency.



Glide Path Performance Chart



3D Track Position

UTC	LAT	LONG	ALT	WIND	GUST
2021-04-11 16:28:38.01	38.03	78.05	2590.32	3.7	12.3
2021-04-11 16:28:38.02	38.03	78.02	2590.30	4.7	14.1
2021-04-11 16:28:38.03	38.04	78.01	2588.39	4.4	11.6
2021-04-11 16:28:38.04	38.03	78.01	2592.39	3.4	13.7
2021-04-11 16:28:38.05	38.03	78.01	2594.03	3.7	17.0
2021-04-11 16:28:38.06	38.04	78.02	2595.08	3.0	14.5
2021-04-11 16:28:38.07	38.04	78.03	2594.90	3.4	11.5
2021-04-11 16:28:38.08	38.04	78.05	2593.32	3.0	13.5
2021-04-11 16:28:38.09	38.04	78.03	2595.86	2.8	13.9
2021-04-11 16:28:38.10	38.04	78.03	2596.64	2.7	14.0
2021-04-11 16:28:38.11	38.04	78.03	2597.43	2.5	14.1

Integrated Data Product

The talk covered the software architecture of NC’s data management system, called Aerograph. Its purpose is to provide a reliable and secure software system that collects, stores, protects, and shares data to support key NC research activities. Through Aerograph’s intuitive user interface, vetted AAM data scientists, aerospace engineers, and analysts will be able to access, preview, and download flight test event data and other derivative analytical artifacts such as aircraft performance charts, wind rose charts, and flight event schedules. The objective of the tech talk was to cover the technical details of Aerograph’s software architecture. During the talk, the ATI Data Services Team delved into Aerograph’s architectural details and discussed topics such as data store technology (e.g., NoSQL databases), inter-process communication technology (e.g., ActiveMQ and Camel), authentication and authorization techniques (e.g., KeyCloak), container-based software deployment (e.g., Docker), and data retrieval (e.g., RESTful interfaces). To further illustrate how all the technology works together, the tech talk also included highly detailed process flow charts on message flow and component processing. A recording of the tech talk will be posted here: <https://www.nasa.gov/aamnationalcampaign/techtalks>.

## SWS SMEs Participate in AFRL Engagements

POC: [NATASHA NEOGI](#) AND [MISTY DAVIES](#)

From May 2–6, the Air Force Research Laboratory (AFRL) conducted an Assurance Case Tech Sprint. System-Wide Safety (SWS) project researchers Natasha Neogi, Mallory Graydon, and Michael Holloway served as subject matter experts (SMEs) by reviewing AFRL’s assurance case to enable the flight test of a neural network in a run-time assurance architecture for their loyal wingman concept. This weeklong effort resulted in feedback provided to AFRL management on May 11 and served as a starting point for aligning assurance case concepts between AFRL and NASA – specifically for the deployment of increasingly autonomous systems in flight environments. On May 18, a meeting was held to initiate a collaborative activity between NASA’s SWS project and the AFRL on the topic of development of safety argumentation for run-time assurance architectures for neural network controllers. This meeting was held to determine relevant external partners to engage. Potential partners who have expressed an interest to engage in this activity include the California Institute of Technology, Dependable Computing, and NodeIn Technologies.

# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

## SWS Researchers Invited as SMEs for DARPA

POC: [NATASHA NEOGI](#) AND [MISTY DAVIES](#)

From May 17–18, researchers from the System-Wide Safety (SWS) project participated as subject matter experts (SMEs) at the Defense Advanced Research Projects Agency (DARPA) Principal Investigator's meeting of [DARPA's Assured Project](#). NASA's SMEs provided feedback regarding the efficacy of assurance arguments as well as inputs regarding forward directions for tackling safety issues for novel human machine teaming paradigms. The Assured Autonomy (AA) effort aims to enable continual assurance of machine learning-enabled systems. Participants are working to create guarantees of safety and functional correctness for the systems – and also creating frameworks and techniques that continually monitor, update, and evaluate the system at operation time as the system and its environment evolves. While the AA research objectives prioritize challenge problems in the militarily-relevant autonomous vehicle space, it is anticipated that the tools, toolchains, and algorithms created will be relevant to other civil aviation and space applications.



*HDV project team members at NASA Langley.*

## HDV Holds Face-to-Face Meeting

POC: [LOUIS GLAAB](#)

From May 18–19, the Advanced Air Mobility (AAM) project's High Density Vertiplex (HDV) subproject conducted a face-to-face planning meeting at NASA's Langley Research Center in Virginia, including personnel from NASA's Ames Research Center in California as well as virtual attendees. A highlight of the meeting was the Urban Air Mobility Air Traffic Operations Lab flyers and the Remote Operation for Autonomous Missions Unmanned Aircraft Automated Flight and Contingency Management subproject manager; Jeff Homola and Lou Glaab, HDV subproject manager and technical leads; Davis Hackenberg, AAM



Mission Integration Office manager; Mike Guminsky, AAM project manager; Marcus Johnson, Advanced Capabilities for Emergency Response Operations project planning manager; and several System-Wide Safety and Air Traffic Management – Exploration project team members. Items on the agenda included capturing of all HDV Advanced Onboard Automation schedule work package accomplishments, lessons learned, and planning.

## SWS Researchers Contribute to Python Prognostics Packages v1.3 Release

POC: [WENDY OKOLO](#)

In May, researchers from the System-Wide Safety (SWS) Emerging Operations Technical Challenge contributed to an updated release

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

of NASA's Prognostic Algorithms Packages. These packages provide modular, extendable tools for creating and simulating degradation (prognostics) models – performing systems health-state estimation and prediction, creating new systems health-state estimation and prediction algorithms, benchmarking prognostics performance, and visualizing results. The three parts to NASA's Python Prognostics Packages are: 1) Prognostics Models ([nasa.github.io/prog\\_models](https://github.com/nasa/prog_models)) - Python modeling framework focused on defining and building models for prognostics (computation of remaining useful life) of engineering systems, available on pip (`pip install prog_models`); 2) Prognostics Algorithms ([nasa.github.io/prog\\_algs](https://github.com/nasa/prog_algs)) - Python framework for model-based prognostics of engineering systems, available on pip (`pip install prog_algs`); and 3) Prognostics As-A-Service Sandbox ([nasa.github.io/prog\\_server](https://github.com/nasa/prog_server)) - Service Oriented Architecture Sandbox for performing prognostics, available on pip (`pip install prog_server`). Multiple updates included in the packages now provide new models, the capability to generate surrogate models automatically, an additional estimator and predictor, and datasets with the ability to access prognostics data programmatically. These tools will help researchers in industry, academia, and government build new

models, algorithms, and software architectures for prognostics.

### SWS SMEs Participate in Autonomy Verification and Validation Workshop

POC: [GUILLAUME BRAT](#) AND [MISTY DAVIES](#)

On May 23, subject matter experts (SMEs) from the System-Wide Safety (SWS) project reviewed and participated in an open industry workshop on the needs for assurance of autonomy. The Autonomy Verification and Validation Workshop, part of a NASA Research Announcement co-sponsored by AOSP and the Transformative Aeronautics Concepts Program, was held at Boeing's El Segundo, California site and was open to all interested participants in industry, academia, and government. The team had already identified key needs and gaps for assurance methods that enable aviation's automation needs. The deep-dive topics covered during the workshop included Model-Based Systems Engineering for Artificial Intelligence/Machine learning (AI/ML), Safety in Human-Autonomy Interaction, Autonomy for Contingency Planning, and Certification Guidance for AI/ML. The roadmap that will be built from this and other future workshops is expected to be completed in September 2022.

### HDV Finalizes Revision to Interconnection Security Agreement

POC: [JEFF HOMOLA](#)

In preparation for upcoming development and testing as part of the Advanced Air Mobility project's High Density Vertiplex (HDV) subproject's Scalable Autonomous Operations (SAO) work package, the existing Interconnection Security Agreement (ISA) was revised on May 23 to enable the integration of new systems and facilities into the HDV system environment. With the final signatures complete, the HDV team will be able to begin initial connectivity tests of the Vertipoint Automation System with Fleet Management and Vertipoint Manager systems – a key feature of SAO. Additional laboratory connectivity at NASA's Langley Research Center in Virginia will be enabled through this ISA revision – enhancing HDV's simulation environment through the availability of additional simulation platforms for inclusion.

### PAAV Meets with RACCA and Empire Airlines

POC: [MIWA HAYASHI](#)

On May 23, a group from the Air Traffic Management – Exploration project's Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject team held a virtual



## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

meeting with Stan Bernstein, president of the Regional Air Cargo Carriers Association (RACCA), and Tim Komberec, chairman and CEO of Empire Airlines. The purpose of the meeting was to discuss the current regional air cargo operations, challenges, and their future visions. RACCA is a group of more than 50 FAA-certificated air carriers in the United States. Empire Airlines is a FedEx Express feeder carrier operating a fleet of mid-size turbo-prop aircraft (ATR-42, ATR-72, Cessna Caravan 208) throughout the western United States. The group discussed the pilot shortage, which is currently a major issue in the regional air cargo industry, and visions for using remotely piloted unmanned aircraft as the solution. The group agreed to meet periodically so that the PAAV team can obtain industry feedback on their current research directions.

### AAM National Campaign IAS Systems Requirements Review

POC: [ADAM YINGLING](#)

On May 23, the Advanced Air Mobility (AAM) project's National Campaign subproject held a systems requirements review for the Integration of Automated System (IAS) activity's first series of flight tests. The review mapped high-level automated flight and contingency management research objectives

to flight test requirements. The review covered the first of two spirals of flights, with the first spiral scheduled for September 2022 at Sikorsky Airport in Connecticut. The first spiral of flight tests will test the infrastructure, interfaces, and flight test services required to properly support the automation algorithms planned to undergo thorough testing during spiral two in September 2023.

### National Campaign Adds New Information Exchange Partners

POC: [KEN GOODRICH](#)

On May 25, Jon Montgomery, deputy associate administrator for policy for NASA Aeronautics, signed four new Industry Partner Advanced Air Mobility (AAM) Space Act Umbrella Agreements under which are four information exchange annexes for National Campaign-2 (NC-2). The new partners include three aircraft developers: Electra Aero, based in Virginia; OverAir, based in California; and Supernal, based in Washington, DC. Supernal is the urban air mobility subsidiary of the Hyundai Motor Company. The fourth partner, Ellis and Associates, is based in California and is an urban technology consulting company specializing in the integration of policy, transportation, and information technology. All the compa-

nies signed information-exchange agreements enabling information exchanges with the National Campaign and other AAM mission projects in support of assessing their readiness, capabilities, and areas of shared interest for participation in NC-2 and other AAM activities. More information can be found at [www.electra.aero](http://www.electra.aero), [www.overair.com](http://www.overair.com), [www.supernal.aero](http://www.supernal.aero), and [www.ellis-and-associates.com](http://www.ellis-and-associates.com).

### DIP Meets with Stakeholders

POC: [MIRNA JOHNSON](#)

In late May, the Air Traffic Management – Exploration project's Digital Information Platform (DIP) subproject held meetings with various stakeholders. The DIP team participated in a presentation at the System-Wide Information Management (SWIM) Industry FAA Team meeting. The presentation provided an update on machine learning services performance and steps toward scalability to other airspaces. Machine learning will enable the reusability of high-value digital services such as arrival/departure runway prediction and taxi time predictions with relatively less site adaptation efforts. Attendees such as Josh Gustin, deputy director of FAA Air Traffic Systems, endorsed the effort by describing it as a long-held collaborative decision-making dream to design services

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

for reuse. The Development and Analytics Focus Group is interested in learning about how NASA is capturing key information and applying data analytics and machine learning to improve operational decision-making. DIP's demonstration for Collaborative Digital Departure Re-routing is being demonstrated to show how SWIM data can be processed to predict key events and strategically propose re-route options to save fuel and improve efficiency.

On May 26, the DIP team provided an overview of upcoming platform evaluation activities to representatives from American Airlines. The DIP team described the reusable digital services that will be made available on the platform later this autumn for partners to connect to. Anticipated partners, such as American Airlines, will be asked to evaluate the accessibility of the services via the platform and provide input for refining the platform concept and enhancing initial capabilities such that they can be incorporated into their suite of operational decision-making tools. These engagements will inform, from the consumer perspective, the desired features of the platform and the standards to enable a marketplace of aviation digital services.

### **PAAV Completes Use Case Development Series and Tabletop Activity**

POC: [WAYNE BRIDGES](#), [ARWA AWEISS](#),  
AND [HUSNI IDRIS](#)

In May, the Air Traffic Management – Exploration project's Path-finding for Airspace with Autonomous Vehicles (PAAV) subproject completed development of a series of use cases. These were designed from an operations perspective and outlined step-by-step actions based on existing procedures and regulations applied to lower large cargo aircraft like the ATR42 600. The use cases considered both physical and agent architectures including communications, command and control (C2) link systems, airspace configurations, Air Traffic Control, Remote Pilot in Command (RPIC), flight crew, ground crew, and dispatching. Seventeen narratives were completed, including an overview of each use case and specific step-by-step actions. Nine narratives highlighted single ship operations. The remaining eight narratives focused on m:N (i.e., multiple operators cooperatively managing multiple assets) operations. Several off-nominal variations primarily focused on lost C2 link were applied to the narratives. The m:N narratives addressed topics unique to unmanned aircraft operations such as position relief, RPIC

to RPIC handoffs, voice communications and data link management, and contingency management. As PAAV began examination of m:N concepts, the use cases were used to inform NASA research and RTCA SC-228 discussions. Primarily, the use cases became the basis for the development of topics and questions for the May 2022 PAAV Concept of Use (ConUse) tabletop, with the goal of vetting concept elements with pilots and controllers by allowing for discussion that would identify gaps and shortfalls with existing procedures and regulations and propose solutions to solve these issues. The use cases also provided examples in support of the PAAV research at NASA's Glenn Research Center in Cleveland and Langley Research Center in Virginia. Initial findings from the tabletop will be included in the ConUse Version 1 document. They will also be used for further discussions at future m:N working group meetings and with industry partners to expand the m:N concept.

On May 27, the PAAV team completed a tabletop activity with controller and pilot subject matter experts (SMEs). The goal of the tabletop was to provide a forum to vet with the SMEs concept elements of integrating unmanned cargo operations into the National Airspace System by allowing for a

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

discussion that would identify gaps and shortfalls with existing procedures and regulations, as well as propose potential solutions to solve these issues. A phased approach was used for the tabletop. In the first session, scheduled from May 16–19, pilots for both manned and unmanned vehicles were presented with 17 narratives, which included nine use cases that highlighted single aircraft operations and eight use cases focused on m:N operations and were asked to assess challenges and solutions to enable such operations. In the second session, scheduled from May 23–26, controllers were presented with the same set of use cases and asked about their perspective. In the third session on May 27, the pilot and controller SMEs were brought together for a joint discussion. A fourth session, scheduled for autumn 2022, will be an out brief to the FAA, industry stakeholders, and academic/research representatives. Findings from the tabletop will be included in the ConUse Version 1 document.

### Kickoff for AAM V2V Communications Standards

POC: [BRYAN BARMORE](#) AND [MISTY DAVIES](#)

On May 31, the RTCA kicked off a working group to write a white paper on gaps and needs for industry standards to support Vehicle-to-Vehicle (V2V) communications

for Advanced Air Mobility (AAM) operations. The kickoff brought together more than 90 participants representing U.S. operators, avionics and vehicle manufacturers, government, and international organizations. Based on growing community interest in V2V for a range of AAM operations and vehicles, RTCA has requested that Special Committee 228 lead the development of a white paper describing the desired scope and the need for future standards development and a proposed roadmap to said standards. Bryan Barmore of NASA's Langley Research Center in Virginia is co-leading this paper with Randy Jacobson of Collins Aerospace. The white paper, which will be presented to the RTCA Program Management Council in December, will represent industry consensus on the types of air traffic operations to be supported, the potential communication protocols, and other critical questions that need to be addressed. A V2V communication standard will enable vehicles to safely and efficiently, contribute to air traffic management for AAM. This work is being coordinated with the Federal Aviation Administration and other regulators to ensure alignment with their needs and constraints. Representatives from NASA's Air Traffic Management – Exploration, System-Wide Safety, and AAM projects are also contributing.

### Tutorial on Runtime Verification with Copilot and Ogma

POC: [ALWYN GOODLOE](#) AND [MISTY DAVIES](#)

On June 3, System-Wide Safety (SWS) project researcher Alwyn Goodloe and Ivan Perez of the National Institute of Aerospace visited Carl Elks's research group at Virginia Commonwealth University in Virginia. The purpose of their visit was to give an extended tutorial on the Copilot Runtime Verification Framework and associated Ogma tool – both developed with SWS project support. In addition to members of Elks's group, faculty members working in the area of robotics were also in attendance. Faculty and graduate students at the University of Virginia attended via Zoom, as did several researchers at the National Institute of Standards and Technology. Elks's group has started using Copilot for work being conducted under a NASA research award, and the tutorial introduced Copilot to those wanting to use it on other projects such as a large award from the Nuclear Regulatory Commission.

# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

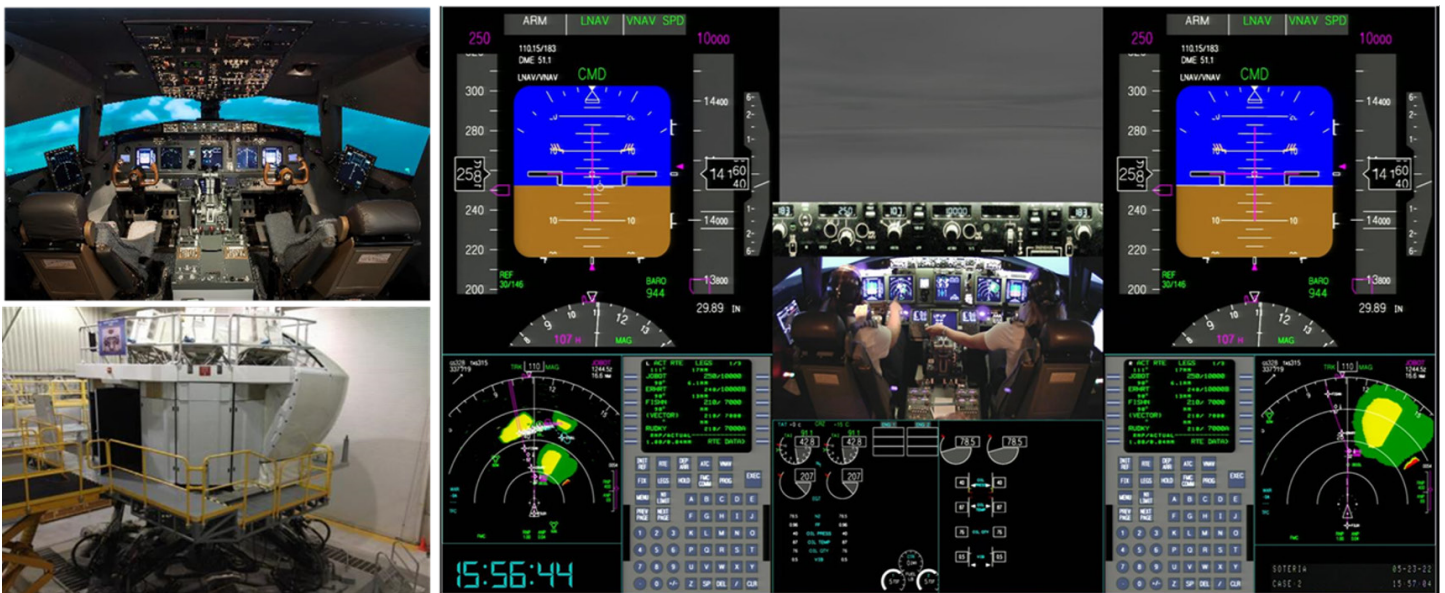
## NASA/Boeing Collaborative SOTERIA Flight Simulation Study

POC: [CHAD STEPHENS](#) AND [MISTY DAVIES](#)

On June 3, System-Wide Safety (SWS) project researchers Chad Stephens, Lance Prinzel, Jon Holbrook, Tyler Fettrow, Michael Vincent, Sepehr Bastami, and Dan Kiggins collaborated with Boeing researchers Jack Dwyer (Research and Technology) and Jim Wilkerson (Standards and Training) under NRSAA 33523 to complete the SWS Operations and Technologies for Enabling Resilient In-Time Assurance (SOTERIA) study. The SOTERIA human-in-the-loop flight simulation

study conducted in the Cockpit Motion Facility Integration Flightdeck (CMF IFD) at NASA's Langley Research Center in Virginia involved 13 commercial aviation Part 121 flight crews with 26 test subjects. The flight crews were recruited to perform flight simulations of eight area navigation standard terminal arrival route (RNAV STAR) arrivals into Charlotte Douglas International Airport in the CMF IFD – a Boeing 737 Next Generation full flight simulator. The focus of the SOTERIA study was collecting and analyzing data on how commercial aviation flight crews handle routine expected and unexpected disturbances in commercial flight

operations to explore human contributions to safety (HC2S). The objective of the study is to understand the factors involved in productive safety demonstrated by flight crews using safe and necessary non-adherence to RNAV STAR arrivals as the operational example. The study involved experimental methodologies including recording (video recording), analysis of flight crew behaviors (eye tracking), psychophysiological responses (electroencephalography, galvanic skin response, temperature), and completion of surveys and interviews during and after the scenarios were performed. The SWS project has world-renowned experts in aviator resilience and



*Caption?*

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

safety-producing behaviors. NASA SWS HC2S researchers are working together with Boeing, airlines, and aviation industry partners to better understand HC2S in various facets of commercial aviation to enable aviation safety.

### New “Sky for All” Vision

POC: [SHAWN ENGELLAND](#)

On June 6, Version 1.3 of the Air Traffic Management – Exploration project’s Sky for All vision was published to the web portal: <https://nari.arc.nasa.gov/skyforall/>. This major update includes the initial version of the community-identified research and development needs. The new Sky for All vision is “a sustainable, safe, resilient, and adaptable future aviation system realized by advanced and continually emerging capabilities for agile, scalable, optimizable, increasingly diverse, and equitable operations in shared airspace.”

### NASA/FAA Meet with Microsoft to Discuss Areas of Collaboration

POC: [WILLIAM CHAN](#)

On June 7, representatives from the Air Traffic Management – Exploration project and an FAA team (which included LS Technologies) met with Microsoft personnel at their Mountain View, California Technology Center to discuss areas of collaboration. The

Microsoft team presented a wide range of their technologies that included using machine learning algorithms on their Azure cloud platform and their work with NASA to detect wear in astronaut gloves. They also showed the capabilities of their Studio Alpha and AirSim platforms. Studio Alpha is a simulation platform for decision-making using Azure that is data driven and artificial intelligence-driven to simulate real-world behaviors in a virtual world. AirSim is an open-source, cross platform simulator for drones and cars plus other vehicles. The next steps include planning another discussion with Microsoft where NASA will present their research toward refining areas of collaboration.

### ATM-X Hosts the NASA/FAA Quarterly Review

POC: [SHAWN ENGELLAND](#)

From June 9–10, the Air Traffic Management – Exploration (ATM-X) project and the FAA held a two-day hybrid quarterly review meeting at NASA’s Ames Research Center in California. The meeting was hosted by the NASA Aeronautics Research Institute. FAA participants included Diana Liang (enterprise portfolio manager), Nabil Sandhu (Advanced Air Mobility Beyond Visual Line of Sight National Airspace System Evaluation lead), Sherri Magyarits (Upper Class E Traffic Management (ETM)

Concept of Operations lead and Research Transition Team co-lead), Nouri Ghazavi (Urban Air Mobility Concept of Operations lead), Matt Moddero, Michelle Cady, and TJ Tejasen. Both days of the meeting consisted of ATM-X presentations on research status and schedule updates from the Digital Information Platform (DIP), Extensible Traffic Management, Urban Air Mobility, and Pathfinding for Airspace with Autonomous Vehicles subprojects as well as the Sky for All vision. In addition to these presentations, Shawn Engelland and Kurt Swieringa led a breakout session on community identified research needs in Sky for All. Jaewoo Jung held a breakout session toward development of an ETM roadmap. Mirna Johnson, Jeremy Coupe, and TJ Tejasen provided an overview and status update on the DIP Sustainable Aviation-1a data collection and the upcoming Sustainable Aviation-2 activity. Representatives from the FAA led discussions on their Unmanned Aircraft Systems Traffic Management Remote ID and Detection Demonstration and Message Security – UTM Integration. The NASA/FAA quarterly review continues to provide both agencies the opportunity to enable deeper technical discussions among the various teams to strengthen future collaborations.

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

### PAAV Completes Space Act Agreements with Stakeholders

POC: [ARWA AWEISS](#) AND [RICHARD COPPENBARGER](#)

The Air Traffic Management – Exploration project’s Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject signed two Space Act Agreements (SAA) this past quarter. On May 11, the PAAV team signed a SAA and corresponding Annex with Northrop Grumman. In support of the vision to achieve full seamless, scalable, robust integration of automated air cargo operations in the National Airspace System (NAS), PAAV will define, plan, and model collaborative demonstrations of Unmanned Aircraft Systems (UAS) cargo operations with Northrop Grumman. The work planned for the first year is under Annex 1 and will focus on relevant demonstrated data of currently developed technologies, advanced procedures, and one or more operating environments required for the future integration of technologies and procedures required for file and fly UAS cargo operations. The plan developed in Annex 1 will be used for a future joint flight demonstration.

On June 15, the Ohio Department of Transportation (ODOT) Space Act Annex was signed to enable a collaboration between the PAAV team and ODOT. The purpose of this collaboration is for the PAAV

team to obtain real-world data from flights with ODOT partners and to gain insights into their operations to refine PAAV concepts and technologies. ODOT will be able to leverage NASA expertise in addressing the barriers to enable routine operations of remotely piloted aircraft in the NAS.

### HDV Completes LSTAR Installation and Assembly

POC: [JEFF HOMOLA](#) AND [LOUIS GLAAB](#)

On June 17, the Advanced Air Mobility project’s High Density

Vertiport (HDV) subproject completed assembling the Lightweight Surveillance and Target Acquisition Radar (LSTAR) radar. The effort began in early May when the HDV subproject first received the mounting platform. Initial assembly began and workers installed the radome on the radar platform. Workers have also installed mounting plates at NASA’s Langley Research Center in Virginia. The plan was to assemble the entire assembly onto the roof. The mount will provide a much better field of view for the LSTAR, which



*Installation of the Radome on the Radar Platform.*

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

is expected to be a key piece of the surveillance infrastructure for HDV's upcoming Scalable Autonomous Operations work package. In June, the LSTAR, radome, and platform were lifted into position on top of NASA Langley's Building B1244 Hangar. This work was performed as part of the HDV subproject's efforts to establish surveillance capabilities to enable beyond visual line of sight (BVLOS) small Unmanned Aircraft System (sUAS) operations at NASA Langley's City Environment Range for Testing Integrated Autonomous Navigation (CERTAIN). From its location atop the hangar, the LSTAR radar will provide coverage out to 20 nautical miles over a 360-degree

horizontal field of view. Tracking information from the LSTAR will be routed to the Remote Operations for Autonomous Missions (ROAM) control room located in the NASA Langley Air Traffic Operations Lab in B1268. Radar tracking data from a pair of panel-type GA-9120 radars, recently installed on NASA Langley's Gantry structure, will provide complementary information to the sUAS operations team of aircraft operating in the vicinity of CERTAIN and beyond. Radar tracking data will also be routed from ROAM to the sUAS in flight and integrated with the Independent Architecture for Reliable Operations of Unmanned Systems to provide autonomous detect and avoid

functionality. Plans call for testing of the integrated system in May 2023 at CERTAIN. Through collaboration within the Longbow Space Act Agreement, a third radar (Raytheon Skyler-2) mounted on Harbor Center in Hampton, Virginia will also be integrated to establish BVLOS maritime corridors in support of envisioned search and rescue operations. On June 10, it was reported that the installation of the LSTAR platform and radome was inspected using a Skydio-2 sUAS. Safety inspections were completed in mid-June, and checkout with the Radar-2 test planned for mid-July 2022.

### ATM-X, xTM, and ILEOS Receive Award for Collaboration

POC: [JAEWOO JUNG](#)

On June 17, the Intelligent Long Endurance Observing Systems (ILEOS), along with the Air Traffic Management – Exploration (ATM-X) project's Extensible Traffic Management (xTM) subproject, received an award for a grant proposal submitted to the Advanced Information Systems Technology Program under NASA's Science Mission Directorate. The xTM subproject supports the collaboration as outlined in the proposal. The ILEOS group and the xTM subproject will continue to discuss areas of future collaboration.



*LSTAR successfully assembled inside the newly installed radome.*

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

### **PAAV Holds Technical Interchange Meeting with Northrop Grumman**

POC: [RICHARD COPPENBARGER](#)

On June 21, the Air Traffic Management – Exploration project’s Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject hosted a Technical Interchange Meeting (TIM) with Northrop Grumman. The meeting, held at the NASA Aeronautics Research Institute at NASA’s Ames Research Center in California, was the first in a series of TIMs planned for the first phase of a Space Act Agreement that was signed in May 2022. The partnership between NASA and Northrop Grumman is aimed at flight demonstrations for validating technologies and procedures needed to integrate remotely piloted operations for scalable and efficient cargo deliveries into the National Airspace System. This initial TIM was focused on airworthiness and certification processes and included topics on the certification of autonomy, airworthiness concerns for contingency management, and methods to calculate the probability of off-nominal events. It was agreed to continue discussions on airworthiness, with a focus on requirements for a potential PAAV flight demonstration at Moffett Field. Preparations were made for a second TIM at Northrop Grumman’s facility near San Diego in August 2022. That

meeting will focus on scenarios for increasingly autonomous air cargo operations to help define specific objectives for flight demonstration and related data collection.

### **SWS SMEs Participate in Plenary for ML/AI Use in Aviation**

POC: [MISTY DAVIES](#)

From June 27–29, several System-Wide Safety (SWS) project subject matter experts (SMEs) on machine learning/artificial intelligence (ML/AI) and the safety assurance of aviation systems participated in the SAE International/European Organization for Civil Aviation Equipment plenary. The plenary was held as a hybrid meeting in Minneapolis and was hosted by the University of Minnesota Software Engineering Center and Collins Aerospace. The purpose of the plenary was to finalize a draft containing consensus recommendations that enable the use of machine learning in both airborne and ground aviation systems. NASA experts participated by providing technical review and by drafting language in support of the document.

### **ATM-X, UAM, and SWS Complete Strategic Conflict Management Simulation**

POC: [KEVIN WITZBERGER](#), [LYNNE MARTIN](#), [STEVE YOUNG](#), AND [EVAN DILL](#)

The Air Traffic Management – Exploration (ATM-X) project’s

Urban Air Mobility (UAM) subproject successfully completed several steps towards developing a Provider of Services for UAM (PSU), while leading seven airspace partners in developing their PSU’s – five of which will partner with Wisk in the National Campaign-1 (NC-1) flight tests. Beginning on April 19, all seven partners (ANRA, Avision, Collins, Metron/Airbus, OneSky, SkyGrid, and Unmanned Experts) and NASA successfully conducted an integration test with Demand Capacity Balancing (DCB) capabilities. Participants generated and updated operational plans to meet defined capacity constraints at vertiports while conforming to the established community-based rules (CBRs) that were also developed as part of the Sprint 5 exercise. This continued the series of Sprint tests to prepare the airspace partners and the NASA PSU for inclusion in the NC-1 flight test. Collaborative Simulation 1 exercised DCB with multiple partners running in the same environment with the window opening for testing on April 25 with an expected end date of May 6. The series of sprints within the scenarios are used to validate features that will be used in a collaborative scenario simulation with the partners that will run between April and June 2022. Additional sprints were conducted in May as the UAM team continued exercising capabilities to receive airspace constraints information. This capability is a required step



## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

toward exercising rerouting of UAM operations in Sprint 7.

On June 30, the UAM team completed the Strategic Conflict Management Simulation (X4) and delivered the UAM airspace software to the Advanced Air Mobility project. The simulation concluded a year-long effort with the dual objective of conducting research and development of the PSU and preparing for the NC-1 test flights. Key requirements were identified, implemented, tested, and evaluated during the course of the simulation effort. Examples of these key requirements include 4D trajectory operational intents, generating estimated times-of-arrival, demand and capacity balancing, and CBRs. By any measure, the X4 simulation was widely successful and impactful to standards development organizations such as ASTM International. Preliminary findings and lessons learned included identifying concept and requirement gaps associated with Unmanned Aircraft Systems Traffic Management concepts and technologies applied to UAM including the discovery and synchronization service and conformance monitoring. A series of lessons learned is expected to be shared beginning later in July 2022. The UAM team will evolve the technologies developed during the X4 simulation to build up to a future planned Tactical Conflict

Management Simulation, or X5. This build-up effort includes developing, implementing, testing, and evaluating a UAM arrival/ departure scheduler to precondition the UAM flights to make the tactical adjustments more efficient and effective.

In cooperation with the UAM study, the System-Wide Safety (SWS) Emerging Operations Technical Challenge (TC-2) participated in the X4 collaborative simulation as well. The TC-2 team was successful in validating their novel dynamic density (DD) metric – demonstrating its successful use as a Supplemental Data Service Provider and showing its ability to interface within a PSU system. This activity involved seven external X4 partners and simulated 100 aircraft through UAM corridors in the Dallas-Fort Worth metroplex. The DD service calculated and published the density of traffic in one corridor in real time to the X4 Extensible Traffic Management data distribution portal and the results for all corridors shortly after run-time end. This satisfied a major project milestone to generate and integrate an airspace complexity metric as part of the ATM-X demonstration. This work was documented in a paper titled “Urban Air Mobility Airspace Dynamic Density” by Spirkovska, L., Kulkarni, C., Watkins, J. and Martin, L. and featured at the AIAA Aviation Forum from June 27–July 1.

### Completion of AEP Collaborative Simulation with the FAA

POC: [MIKE FEARY](#) AND [JOHN KANESHIGE](#)

The Advanced Air Mobility (AAM) project’s Automated Flight and Contingency Management (AFCM) subproject’s Automation-Enabled Piloting (AEP) principal investigators hosted an FAA-sponsored simulation test in the Vertical Motion Simulator at NASA’s Ames Research Center in California from June 13–July 1. This work leveraged electric vertical takeoff and landing (eVTOL) vehicle performance models and automation and control concepts developed to support AFCM’s Integrated Pilot Requirements and Aircraft Handling and Operations research areas, as well as supports the FAA’s evaluation of possible means of compliance flight test maneuvers for eVTOL aircraft for certification of candidate AAM aircraft.

## RECOGNITION

### Careers at NASA Highlighted at Brewster's Middle School Virtual Career Day

POC: [RANIA GHATAS](#)

On May 5, Rania Ghatas of the Air Traffic Management – Exploration project's Urban Air Mobility (UAM) subproject volunteered to speak to a class of middle school students at Brewster Middle School located in Camp Lejeune, North Carolina as part of their virtual career day. Ghatas spoke to the students about the many different career opportunities available at NASA, and her talk focused on her career at NASA as a human factors researcher currently working on the Human Research Program Multi-Model Ensemble Risk Assessment Visualization Team and the UAM subproject. Ghatas shared two outreach videos with the students including a three-minute video highlighting the many research efforts and capabilities within the Crew Systems and Aviation Operations Branch at NASA's Langley Research Center in Virginia, and a three-minute video highlighting the UAM subproject, which was previously shown during a panel discussion at EAA AirVenture Oshkosh in Summer 2019. This talk was organized by NASA Langley's Speakers Bureau.

### NASA Researcher Receives Best Thesis Award

POC: [BRANDON COOK](#)

On Feb. 4, Jaewoo Jung from the Air Traffic Management-eXploration (ATM-X) project's Extensible Traffic Management (xTM) subproject presented in a virtual seminar to a group of students and faculty at LeTourneau University in Longview, Texas. Jung provided an overview of NASA's xTM research, including Upper Class E Traffic Management and the interactions between xTM-supported highly-automated operations and human-centric conventional air traffic operations. The seminar concluded with a question-and-answer session, where the students and faculty asked about technology and NASA in general.

### Airspace Integration Panel at the Ohio Advanced Air Mobility Symposium

POC: [WILLIAM CHAN](#)

From April 7–8, Air Traffic Management – Exploration (ATM-X) project management leadership attended the second annual Ohio Advanced Air Mobility Symposium, Pioneering the New Age of Aviation, at Ohio State University (OSU). The two-day event featured trips to the Springfield-Beckley Municipal Airport and Ohio State Research

Centers to showcase flight simulators, vehicle viewings, and tours of the facilities. The symposium also featured a full day of moderated panels at OSU's Fawcett Center. The second day, April 8, featured remarks by the president of OSU and the lieutenant governor of Ohio, followed by panel discussions and a keynote by Bob Pearce, NASA's associate administrator for aeronautics. William Chan, ATM-X project manager, spoke on the first panel about airspace integration and Davis Hackenberg, mission integration manager for NASA's Advanced Air Mobility Mission Integration Office, spoke on a panel about the supply chain for Advanced Air Mobility. To learn more about the event, visit: <https://u.osu.edu/ohiouamsymposium/2022-event/>.

### xTM Invited to Present at International Astronautical Congress

POC: [DAVID MURAKAMI](#)

On April 19, the International Programme Committee for the 73rd International Astronautical Congress informed the Extensible Traffic Management (xTM) subproject of its acceptance of David Murakami's abstract "A Framework for Space Launch and Re-Entry Traffic Management." Murakami and his team have been

## RECOGNITION

exploring the potential use of an xTM architecture for managing space launch and recovery traffic, which has been growing in number and frequency during the past decade and is expected to grow further as more low Earth orbit satellite-based communications services come online. This is even more important with the entry of rocket cargo operations that the U.S. Transportation Command and the U.S. Air Force are exploring. The team is planning to submit a full manuscript and present it at the congress, scheduled for the week of Sept. 18-22 in Paris.

### AOSP Projects Support AUVSI Xponential 2022

POC: [SHIVANJLI SHARMA](#), [KURT SWIERINGA](#), AND [JEFF HOMOLA](#)

AOSP projects played a prominent role at the Association for Unmanned Vehicle Systems International (AUVSI) Xponential 2022 Conference the week of April 25. During the conference, the National Campaign (NC) subproject team met with partners from industry, government organizations (including the Office of the Undersecretary for Research and Engineering, Air Force Research Laboratory Technology Directorate, AFWERX, and Army Research Labs), and



*Shivanjli Sharma participating on Designing Autonomy in the Sky Panel at AUVSI.*

academia to foster an exchange of information and potential strategic partnerships. In addition, the NC team supported a panel on April 28, titled “Designing Autonomy in the Sky,” which focused on the role of automation to enable the integration of both crewed and uncrewed systems and areas of research required to enable increasing levels of automation onboard vehicles and in the air traffic management system.

On April 27, Kurt Swieringa, the Air Traffic Management – Exploration (ATM-X) deputy project manager for technology, moderated a 45-minute panel session titled “NASA is

Defining the Future of Air Traffic Management” that provided an overview of applicable research areas being conducted within NASA’s ATM-X project. The panelists included the principal consultant at GXA Consulting, LLC, Jay Shively of NASA (Senior Scientist - Human Autonomy Teaming Lab), and Jeffrey Homola of NASA (Upper Class E Traffic Management (ETM) Concept and Evaluation lead/ High Density Vertiport Airspace Systems Integration lead within the Advanced Air Mobility project). Homola presented an overview of the ongoing efforts in ETM research, its relationship to other areas of Extensible Traffic Management,

## RECOGNITION

ATM-X, and beyond, as well as the key relationships with the FAA and industry. The panelists provided a 30-minute overview of applicable research areas being conducted within NASA's ATM-X project followed by a 15-minute question and answer session by the attendees. Session Link: <https://www.xponential.org/xponential2022/public/SessionDetails.aspx?FromPage=Speakers.aspx&SessionID=4206&nav=true&Role=U%27>

### SWS Presents at Aviation Safety InfoShare

POC: [NIKUNJ OZA](#)

From April 26–28, representatives from the System-Wide Safety (SWS) project presented several briefings at the Aviation Safety Spring InfoShare meeting. Briefings included “Detecting Oceanic Deviations using Space-Based ADS-B” by Nikunj Oza; “Short-Haul Fatigue: Research Plan and Results of a Focus Group Study” by Cassie Hilditch and Hannah Baumgartner of the FAA Civil Aerospace Medical Institute; and five talks including “NASA ASRS Cabin Crew Reports: COVID-Related Issues,” “NASA ASRS: Contributions to Rotorcraft Safety,” “NASA ASRS: Turbulence Events,” “NASA ASRS: Contributions to Business and General Aviation Safety,” and “NASA ASRS: Maintenance-Related Reports” by Mary Keller. The purpose of this workshop was to

engage the commercial aviation industry, government agencies, manufacturers, and others to discuss aviation safety incidents, their causes, methods through which the incidents were found, causes identified, and approaches to mitigate these safety issues. The conference was held in St. Louis. The website for this conference can be found at the following website: <https://www.infoshare.us/>.

### AFCM Participates at Vertical Flight Society Forum 78

POC: [MICHAEL FEARY](#)

The Advanced Air Mobility (AAM) project's Automated Flight and Contingency Management (AFCM) subproject supported the Vertical Flight Society 78th Annual Forum and Technology Display Conference, “Forum 78,” held in Fort Worth the week of May 9. AFCM research contributed to the technical paper “Towards Handling Qualities and Automation Assessment for Certification of Electric Vertical Takeoff and Landing (eVTOL) Aircraft” by Michael Jones and David Klyde of Systems Tech.; R. Schaller, D. Sizoo, D. Webber, and J. van Houdt of the FAA; R. Simmons of NASA/FAA (ret).; D. Mitchell of Mitchell Aero.; M. Feary of NASA; and M. Schubert of Tiltrotor Flight Test Consulting. Klyde presented the paper during the “Handling Qualities II” technical session. During the conference,

Klyde also met with government and industry colleagues to foster an exchange of information and potential strategic partnerships.

### ATM-X Panel Participates at Conference Focused on Public-Private Partnerships

POC: [SHIVANJLI SHARMA](#)

On May 10, Shivanjli Sharma, Air Traffic Management – Exploration (ATM-X) deputy project manager, participated in a panel discussion entitled “Smarter Way to Enable Advanced Air Mobility Through Public Private Partnerships” at the inaugural Utah Aerospace Conference. The panel included members from NASA, industry, and the Technology Directorate of the Air Force Research Laboratory and focused on the methods and processes for industry, state governments, academia, and federal agencies to collaborate on Advanced Air Mobility (AAM) concepts and research. The discussion highlighted the efforts of NASA in leading research needed to support disparate mission types, emerging electric vertical takeoff and landing vehicles, increasing automation onboard the flight deck, and airspace concepts to enable high volume and tempo operations. In addition, it was noted that community partnership engagement was essential to enable this industry by taking an AAM ecosystem approach.

## RECOGNITION

### **SWS Presents to NATO Science and Technology Organization on UAS Flight Testing**

POC: [MICHAEL VINCENT](#)

Michael Vincent, System-Wide Safety (SWS) associate project manager, participated at the North Atlantic Treaty Organization (NATO) Systems, Concepts, and Integration (SCI-328) Symposium on Unmanned Aircraft Systems (UAS) Flight Testing in Segovia, Spain on May 12–13. Vincent presented a paper on “Unmanned Aircraft System (UAS) Flight-Test Approach Supporting the Development of Regulatory Recommendations for Integration with the National Airspace System,” which described the series of flight tests conducted during the UAS Integration in the National Airspace System (NAS) project to inform the minimum performance standards for Detect and Avoid (DAA) systems contained within RTCA Inc., DO-365. The presentation included detailed results from the Flight Test 6 full mission effort, which tested full DAA system performance with a human in the loop in a Live-Virtual-Constructive (LVC) simulation of the NAS. The technique of using LVC technology to collect data from human subjects can be broadly applied in the NATO mission to test and develop new technology as well as train pilots and UAS operators.

### **Keynote Presentation at 2022 University of Oxford Business School Conference**

POC: [WENDY OKOLO](#)

Wendy Okolo, System-Wide Safety associate project manager, gave the keynote speech at the University of Oxford Saïd Business School’s Future of Major Programme (FMP) Management Conference on May 19. The talk, “What Drives Cutting-Edge Aerospace Research?,” provided her aerospace research and project management perspectives on the future of major programs defined by complexity, scale, and stakeholder impact. The Oxford FMP Management Conference is the global biennial conference for major programs and large-scale projects. The 2022 conference focused on the cutting edges – defining the extremes of new and innovative major program ideas and research and their potential for impact in practice. Spanning wide-ranging activities including energy, healthcare, defense, aerospace, water, and sanitation, major programs are defined by their complexity and large-scale and transformative impacts on multiple stakeholders. The three-day virtual conference provided a unique forum for participants to exchange ideas, research, contacts, and opportunities by drawing together academics, practitioners, policymakers, and students.

### **SWS Researcher Participates in the 2022 IEEE ICRA**

POC: [AARON DUTLE](#) AND [MISTY DAVIES](#)

The System-Wide Safety (SWS) project was a significant contributor at the 13th annual NASA Formal Methods (NFM) Symposium held from May 24–27. The event was hosted in-person at the California Institute of Technology and allowed virtual participation as well. The SWS project was well-represented, including Ivan Perez, who served as program chair. Aaron Dutle, Alwyn Goodloe, Anastasia Mavridou, Corina Pasareanu, Ewen Denney, Johann Schumann, Misty Davies, and Natasha Neogi all served as members of the program committee. Anastasia Mavridou, research computer scientist at KBR Inc., gave an invited tutorial “Capturing and Analyzing Requirements with FRET,” and Paolo Masci, senior research scientist at the National Institute of Aerospace, presented “Proof Mate: An interactive proof helper for PVS.” The widespread use and increasing complexity of mission- and safety-critical systems at NASA and in the aerospace industry requires advanced techniques that address these systems’ specification, design, verification, validation, and certification requirements. The NFM Symposium provides a forum to foster collaboration between theoreticians and practitioners from NASA, academia, and industry and

## RECOGNITION

is one of the premier conferences in formal methods. The NFM offers an opportunity for external researchers to learn about the problems NASA is addressing, highlighted this year in a keynote by Steve Chien, senior research scientist at the Jet Propulsion Laboratory entitled “Formal Methods for Trusted Space Autonomy: Boon or Bane?” The website for the event can be found at <https://nfm2022.caltech.edu/>.

### **SWS Presents IASMS Concept at Japan Drone 2022/ Advanced Air Mobility**

POC: [KYLE ELLIS](#)

On June 22, Kyle Ellis of NASA’s System-Wide Safety (SWS) project was invited to present NASA’s In-Time Aviation Safety Management System (IASMS) concept at the Japan Drone and International Advanced Air Mobility (AAM) 2022 combined conference and exposition. This activity is important as it engaged the international community and key stakeholders to share system-wide safety considerations and solutions to overcome the technical challenges facing the AAM industry. The IASMS concept was well received and outlined the need for industry collaboration to advance and demonstrate the IASMS concept as an essential safety framework to enable safe, sustainable, efficient, and scalable

AAM operations around the planet in a transformed airspace.

### **NASA SMEs on Steering Committee for FAA Aviation Data Challenge**

POC: [MISTY DAVIES](#)

On June 29, NASA subject matter experts (SMEs) from the System-Wide Safety project served on a Federal Aviation Administration (FAA)-led data challenge steering committee regarding the use of machine learning and artificial intelligence for safety in aviation. The purpose of the FAA data challenge is to encourage students to work on real problems at the intersection of data science and aviation – helping to advance aviation and to build a skill pipeline for the future workforce. The FAA data challenge will launch in August 2022 and conclude in June 2023 and is designed to be a capstone-like competition for engineering and data science students.

### **SWS Presents at the 2022 HCII Conference**

POC: [PAUL KROIS](#) AND [MISTY DAVIES](#)

System-Wide Safety (SWS) project researcher Paul Krois presented a paper entitled “Human Interfaces and Management of Information (HIMI) Challenges for ‘In-time’ Aviation Safety Management Systems (IASMS)” at the Human-Computer Interaction International

(HCII) Conference 2022 that was held virtually from June 26–July 1. The paper flows from research being accomplished by the SWS project developing the IASMS Concept of Operations and examined the unprecedented challenges from the envisioned transformation of the National Airspace System to integrate an IASMS for assuring safety in Advanced Air Mobility. These challenges included the design of human interfaces and management of safety information for integrating potential new critical safety risks with novel types of aircraft and other vehicles having different performance capabilities, flying in increasingly complex airspace, and adapting contingencies to manage normal and non-normal operations. This paper is important in describing the need for innovative new ways for humans to interact with data and manage information compelled by integration of predictive modeling, data analytics, machine learning, and artificial intelligence to effectively address known hazards and emergent risks. Because the roles of humans will dynamically evolve in increments with this technological and operational evolution, the interfaces for how humans will interact with increasingly complex and assured systems designed to operate autonomously, and how information will need to be presented, are important

## RECOGNITION

challenges to be resolved. The HCII conference brought together a worldwide community of experts in cognitive engineering, human-computer interface design, and other areas researching and developing interfaces for a wide range of applications.

### **AOSP Projects Participate in AIAA Aviation 2022**

POC: [WILLIAM CHAN](#), [ERSIN ANCEL](#),  
AND [PORTIA BANERJEE](#)

The Air Traffic Management – Exploration (ATM-X) and System-Wide Safety (SWS) projects proudly represented AOSP at the AIAA Aviation and Aeronautics Forum and Exposition 2022 Conference in Chicago from June 27–July 1. The ATM-X project’s Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject participated in two special sessions and multiple papers for Urban Air Mobility (UAM) and Extensible Traffic Management (xTM) were presented at the conference. The xTM subproject papers covered topics from integration of xTM operations into the National Airspace System (NAS) and specific issues related to the use of the xTM construct for high-altitude operations. There were also papers describing the UAM Airspace Research Roadmap and noise impacts due to UAM operations. The two ATM-X organized special sessions for PAAV covered a wide range of topics

from describing the challenges of integrating remotely piloted aircraft into the NAS to specific technical papers. The technical papers included a review of potential routes for increasingly autonomous air cargo operations, a framework for decomposing the functions necessary to ensure safe and efficient operations, a risk evaluation methodology for unmanned aircraft approach and landing operations, and the impact of communication latency on ensuring safe separation for remotely piloted aircraft.

The SWS project also participated. Eleven papers were submitted under the technical discipline Air Transportation System (ATS) presenting research outcomes from SWS work. This topic encompassed technical papers describing the advancement of air transportation systems and operations and two in-person sessions including SWS I, chaired by Ersin Ancel and Natasha Neogi, and SWS II, chaired by Steve Young and Jane Cleland-Huang. These sessions were organized by SWS project researchers Portia Banerjee and Ersin Ancel in close coordination with ATS technical chairs. Participants in both sessions were highly engaged with the more than 40 attendees and had a lively follow-up discussion after individual talks. Additionally, a few SWS papers were presented at the virtual session “Advanced Air Mobility

Operations and Sustainability II.” Reported research highlighted the significant advancements in the readiness level of individual SWS services, functions, and capabilities while providing the capabilities of the collective use of these advancements. Research progress from university collaborations with George Washington University, Vanderbilt University, University of Texas at Austin, Massachusetts Institute of Technology Lincoln Laboratory, University of Notre Dame, Iowa State University, and Virginia Commonwealth University in SWS projects under the NASA Research Agreement grants were presented in these sessions.

National Aeronautics and Space Administration

**Headquarters**

300 E. Street, SW

Washington, DC 20024

[www.nasa.gov/aeroresearch](http://www.nasa.gov/aeroresearch)

[www.nasa.gov](http://www.nasa.gov)