National Aeronautics and Space Administration

AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

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AOSP IN THE NEWS

U.S. FAA Names Experts to Review Boeing Safety Culture After Fatal Crashes

Reuters (1/5) reports "the Federal Aviation Administration (FAA) said Thursday it had named 24 experts to review Boeing's safety management processes and how they influence Boeing's safety culture after two fatal 737 MAX crashes killed 346 people. The panel, which was required by Congress under a 2020 law to reform how the FAA certifies new airplanes, includes MIT lecturer and aerospace engineer Javier de Luis whose sister was killed in a MAX crash, as well as experts from NASA, the FAA, labor unions, Airbus, Southwest Airlines, American Airlines, United Airlines, GE Aviation, FedEx Express and Pratt & Whitney."

Northrop Grumman and NASA Form Partnership for UAS Airspace Integration

Avionics International (1/12) reports "Northrop Grumman announced a new collaboration with NASA today. Their efforts will center around development and testing of solutions for the integration of large UAS (uncrewed aircraft systems) into the national airspace. The primary focus of the partnership is defining technologies and procedures to enable remotely piloted air cargo operations."

For NASA, Northrop Studies Flying Uncrewed Cargo Aircraft In NAS

Aviation Week (1/13) reports "NASA has contracted with Northrop Grumman to study integrating uncrewed cargo aircraft in the National Airspace System (NAS). For the project, the company plans to conduct a series of simulations, tests and demonstrations to come up with potential framework recommendations for operating autonomous..."

NASA Is Building an AAM System to Make Air Taxis, Drone Deliveries a Reality

Tech Times (2/3) reports "NASA is looking into the future, seeing taxis flying into the skies and drone deliveries becoming more widespread and advanced. The space agency is currently developing a system to make medical and emergency drones and air taxis soaring over traffic a reality."

What Can We Do to Make Sure the FAA and Southwest Airlines Fiascos Never Happen Again?

Scientific American (3/2) reports "perhaps unknowingly, airline passengers who lived through the outage of the Federal Aviation Administration's (FAA's) Notice to Air Systems (NOTAM) system in January or Southwest Airlines' meltdown in December were part of history. The NOTAM outage was the first time the FAA paused all domestic departures in the U.S. since 9/11. ... Niznik attributes this project's success to multiple factors, including strong stakeholder participation, an agile software development process and the fact that NASA, which co-led this project with the FAA, had a dependable source of funding that accommodated unanticipated challenges."

AOSP IN THE NEWS

Air Taxi Developers Expect ADS-B Tracking to Have a Big Role in Crowded Skies

Tech Times (2/3) reports "NASA is looking into the future, seeing taxis flying into the skies and drone deliveries becoming more widespread and advanced. The space agency is currently developing a system to make medical and emergency drones and air taxis soaring over traffic a reality."

Op-Ed: Removing Airline Pilots from the Flight Deck Is A Gamble With Safety

Aviation Week (3/8) reports "if you're planning an international trip this year, you're not alone. Passengers in North America have returned to the international skies in greater numbers than anywhere else in the world. Passengers know that flying is safe—at least for now. ... Beyond our personal experience as airline captains who fly internationally, conclusive research, such as a 2017 study by NASA and the FAA, clearly lays out the unacceptable safety risk posed by single-pilot flight operations, especially during abnormal events."

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

HDV simulation shakedown with all systems in the loop and all facilities connected

HDV Completes SAO-PAO Simulation

POC: LOU GLAAB

The Advanced Air Mobility (AAM) project's High Density Vertiplex (HDV) subproject research team successfully concluded its Scalable Autonomous Operations Prototype Assessment Operations (SAO-PAO) Human-Hardware-in-the-Loop simulation this past quarter. An initial step was the successful deployment of the HDV Client software on the government's Amazon Web Services cloud – completed in January in collaboration with the Air Traffic Management – Exploration project and Freddie teams at NASA's Ames Research Center in California. Deployment of the HDV Client

enabled multicenter integration to proceed in support of the simulation testing. Following this deployment on Feb. 20–24 the team began conducting integrated systems testing in preparation for the simulation, which began on March 1. The HDV ecosystem incorporating the

vertiport automation system, fleet management, vehicle automation, airspace systems, infrastructure, and live virtual constructive capabilities were connected across facilities at both NASA Ames and NASA's Langley Research Center in Virginia. The objectives of the SAO Schedule Work Package for HDV are to:

Remote Operations for Autonomous Missions (ROAM) Used for Testing

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

1) connect fleet management tools and airspace management services to Unmanned Aircraft Systems ground control stations; 2) develop and test a vertiport automation system; and 3) conduct a demonstration of vehicle, airspace, and vertiport automation technologies supporting dense operations at a vertiport. The SAO-PAO simulation contributes to these objectives. For SAO-PAO, human test subjects include ground control station operators, a fleet manager, and vertiport manager. The HDV team completed the simulation on March 17, marking the conclusion of the phase of testing aimed at evaluation of the Urban Air Mobility ecosystem. The SAO-PAO simulation included representative onboard autonomous systems, airspace management systems, ground control and flight management systems, and vertiport automation systems. This test will be followed by the SAO-PAO flight test as well as the Beyond Visual Line of Sight simulation and flight testing later in Fiscal Year 2023.

SWS SME Named by FAA to Review Boeing Safety Culture
POC: MISTY DAVIES

System-Wide Safety (SWS) project researcher Immanuel Barshi was named recently as one of 24 subject matter experts selected by the FAA to review Boeing's safety management processes and how they influence safety culture, following two fatal 737 MAX crashes which resulted in the deaths of 346 people. The panel is "required by Congress under a 2020 law to reform how the FAA certifies new airplanes, includes MIT lecturer and aerospace engineer Javier de Luis, whose sister was killed in a MAX crash, as well as experts from NASA, the FAA, labor unions, Airbus, Southwest Airlines, American Airlines, United Airlines, GE Aviation, FedEx Express and Pratt & Whitney."

DIP Team Holds Virtual Meeting with Collins Aerospace
POC: MIRNA JOHNSON

On Jan. 9, the Air Traffic Management – Exploration (ATM-X) project's Digital Information Platform (DIP) subproject team held a virtual meeting with a team from Collins Aerospace's data science team, who are developing digital integrated aviation solutions. The Collins team provided an overview of their organization and the capabilities they are working on across the aviation value stream including airport operations, airline operations, ground operations, air traffic management, and Unmanned Aircraft Systems Traffic Management and Advanced Air Mobility operations. The DIP team provided an overview of the DIP platform concept and discussed DIP partnership opportunities for aviation service providers to research and evaluate the platform. Collins has aviation data services and ground prediction services that can be registered on the DIP platform to grow the ecosystem of digital aviation information. Some of the services are potential capabilities needed for DIP's upcoming Sustainable Flight National Partnership Operations-2 demonstration of flight profile optimization for contrail avoidance. The DIP team will release an Announcement for Collaboration to which Collins can respond to partner with NASA on these activities. The next step is to have a deep dive technical meeting on the services identified.

SWS and AAM Conduct Informal Interagency and Industry Aviation Safety Forum
POC: NATASHA NEOGI AND MISTY DAVIES

On Jan. 9–13, researchers from NASA's System-Wide Safety (SWS) and Advanced Air Mobility (AAM) projects met with members from the National Transportation Safety Board, the FAA, Joby Aviation, Collins Aerospace, and Reliable Robotics at NASA's Langley Research Center in Virginia. The purpose of the meeting was to informally engage select members of the aviation community to identify challenges and potential research solutions to issues surrounding the assurance of increasingly autonomous systems in emerging aviation markets. Specific discussions centered on the following areas: 1) data collection and curation for accident investigation; 2) capturing human contributions to safety in novel (and existing) operations; 3)

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handling emerging technologies such as machine learning algorithms; and 4) complexity and change management. Representing the National Transportation Safety Board was managing director Dana Schulze, chief technical advisor of air carrier and space investigations Joe Sedor, and senior human performance investigator Dujuan Sevillian. The FAA representatives included chief scientific and technical advisor for aviation human factors Kathy Abbott, and chief data officer Natesh Manikoth. George Romanski, the FAA's chief scientific and technical advisor for airborne computer software, attended virtually. Leaders in the safety efforts from Joby Aviation, Collins Aerospace, Reliable Robotics, and other conventional and emerging aviation industry stakeholders attended the forum and provided perspectives related to the tension between deploying novel technology and ensuring its safety in a timely and cost-effective manner. NASA participation encompassed members across both NASA Langley and NASA's Ames Research Center in California through a hybrid meeting format. Follow-up interactions have been scheduled to leverage potential partnership opportunities to provide a force multiplier across interagency and industrial research efforts.

ETM Team Conducts Multi-Day Tabletop with Industry Operator Focus
POC: CONNIE BRASIL

On Jan. 10–11, the Air Traffic Management – Exploration project Extensible Traffic Management subproject's Upper Class-E Traffic Management (ETM) team conducted a virtual tabletop session with high-altitude vehicle and operations experts representing seven different industry partners. The tabletop event utilized a four-hour time period for each of its two days, with interactive sessions focused on the development of Cooperative Operating Practices (COPs) in regard to strategic conflict detection between high-altitude, uncrewed, and slow High-Altitude Long Endurance (HALE) aircraft such as balloons, airships, and fixed-wing vehicles. The approach to the tabletop was to follow a roadmap that was developed by the ETM team to guide the participants along a path to understanding the ETM system research underway at NASA and how the further development of the concept will inform the future testing planned as part of the Extensible Traffic Management subproject. The first area of discussion focused on the fundamental elements pertaining to the creation of operation plans and corresponding operation intents.

An initial familiarization session was followed by an interactive discussion with valuable participant input. The first day concluded with the administration of an online questionnaire corresponding with the day's discussions on operation plans and intents. The second day focused on familiarization of strategic conflict detection research and a deep dive on the related topic of operational intent intersections. The final topic of discussion was the notion of using COPs as part of the strategic management process through the resolution of intent intersections. Each focus area on the second day concluded with the administration of a corresponding online questionnaire. Overall, the ETM tabletop event provided detailed insights to the NASA research team by the industry partners and vice versa. The main goal behind this tabletop was to drive the research and prototyping requirements to support conducting a collaborative evaluation with a set of partners later this calendar year. With the data and insight gained, the team will be ready and able to test and demonstrate an early reference ETM system that incorporates the current work with the community in designing COPs. In the near term, the ETM team will review the discussion sessions and questionnaire data with plans to produce a written report and

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subsequent presentations to stakeholders.

ACERO Project Members Attend NASF Meeting

POC: JOEY MERCER AND CHARLES SHEEHE

On Oct. 12, members of NASA's Air Traffic Management – Exploration project's Urban Air Mobility (UAM) Airspace Management subproject visited the FAA's William J. Hughes Technical Center. The UAM team was joined by Adam Yingling, the Advanced Air Mobility National Campaign integration of automated systems lead, and Gerrit Everso, the National Campaign partner demonstration technology lead. NASA representatives met with FAA personnel including Marty Suech, operational integration and test strategic coordinator; John Bradley, air traffic control subject matter expert; Tom Rubino, verification and validation strategies and practices branch representative; and Chuck Romano, the strategic initiatives coordinator for test and evaluation. The purpose of the meeting was to discuss the joint NASA/FAA UAM Maturity Level (UML)-3 Operational Integration Assessment (OIA) scheduled for 2025. Discussion topics ranged from sharing lessons learned from Dallas/ Fort Worth International Airport and Atlantic City International Airport simulated airspace procedures and

design efforts to NASA, FAA, and industry-expected UML-3 OIA roles and responsibilities. Two important outcomes of the meeting include: 1) identifying a need to connect a facility at NASA's Ames Research Center in California to the existing NASA/FAA Laboratory Integrated Test Environment to ensure the research objectives can be satisfied, while also establishing a persistent capability that other Advanced Air Mobility efforts can leverage after the UML-3 OIA is completed; and 2) informing opportunities for future NC flight tests with UAM airspace simulation efforts. During lunch, Kevin Witzberger, UAM subproject manager, and Ian Levitt, UAM principal engineer, met with Eric Neiderman, deputy director of the William J. Hughes Technical Center, and informally talked about Advanced Air Mobility ecosystem research needs and potential opportunities to establish shared capabilities across NASA/FAA organizations to help address the research needs.

DIP Team Visits JetBlue Systems Operation Center

POC: MIRNA JOHNSON, JEREMY COUPE AND YOON JUNG

On Jan. 11, team members from the Air Traffic Management – Exploration project's Digital Information Project (DIP)

subproject visited the JetBlue Airways System Operations Center in New York for a technical information meeting on their operations and airspace procedures. The DIP team was welcomed by Christopher Gottlieb, manager of business intelligence at JetBlue, and his team consisting of data and operations analysts. In addition to a tour of the JetBlue facility, the teams discussed operational challenges in critical airspace, particularly related to reroute management and the potential benefits of Collaborative Digital Departure Reroute services developed by NASA. JetBlue expressed interest in other NASA-developed prediction services identified as potentially useful for data-driven analytics and decision making such as taxi time prediction and National Airspace System-wide traffic management initiatives digital services. JetBlue is looking forward to partnering with the DIP team to participate in upcoming demonstrations of the Collaborative Digital Departure Reroute services in a Fiscal Year 2024 sustainability demonstration.

HDV Team Conducts sUAS Flight Operations at Fort Monroe

POC: LOU GLAAB

On Oct. 15, the FAA released an announcement for their 2023

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Photo of HDV test team with small-unmanned aircraft system

FAA Data Challenge. The goal of the Data Challenge is to stimulate universities to apply artificial intelligence and machine learning to address aviation applications. As a regulator and operator, the FAA's diverse mission activities collect and generate a tremendous amount of data. This data and information must be leveraged to its fullest extent possible to enable the mission, which is to provide the safest and most efficient aerospace system in the world, drive efficiency, improve accountability, fuel innovation, exploit the use of data, and embrace modern analytical techniques. The Data Challenge will provide proofs of concept for novel solutions and will also provide a pipeline for talented students at the intersection of computer science and aviation. System-Wide Safety (SWS) project subject matter experts Misty Davies and Nikunj Oza are contributing to this effort. For more information, visit https://faadatachallenge.nianet.org/2023-competition-overview/

DIP SFNP Operations-2 Team Meet with Google
POC: SWATI SAXENA

On Jan. 18, the Sustainable Flight National Partnership (SFNP) Operations-2 team within the Air Traffic Management – Exploration project's Digital Information Platform (DIP) subproject met with the Google Climate Impact Research Team to discuss Google's contrail research. Google presented their paper on quantifying the model uncertainty of climate impacts due to contrails by region and time of day and demonstrated their tool for predicting contrail formation regions in United States airspace. The DIP team provided an overview of their subproject and the objective of the SFNP Operations-2 demo. Next steps include identifying specific research opportunities between Google and the DIP team.

SWS and Embry Riddle Conduct Technical Interchange Meeting
POC: LANCE PRINZEL

The System-Wide Safety (SWS) project and Embry-Riddle Aeronautical University conducted a technical interchange meeting at the latter's Daytona Beach campus on Jan. 20. The purpose of the meeting was to explore partnership

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and collaboration opportunities focused on In-time Aviation Safety Management Systems (IASMS). Specific discussions were included: 1) safety management structure at Embry-Riddle; 2) data types collected such as safety performance indicators, flight data monitoring, and flight data logged parameters; 3) how Embry-Riddle works with and uses GE Aviation products; 4) how Embry-Riddle analyzes the data collected from a safety management perspective (e.g. aggregated data analyses, how it is visualized, etc.); 5) which safety taxonomies and ontologies are used; and 6) opportunities Embry-Riddle is receptive to in terms of collecting other Safety Management System (SMS) type data not currently being collected (Embry-Riddle would like to have an active SMS program, such as Line Operations Safety Assessment). Because Embry-Riddle has an SMS International Standard for Business Aircraft Operations (ISO-BA Level 3), with similar data systems as Part 121 airlines but without some of the challenges of data sensitivities (e.g. Allied Pilots Association; Air Line Pilots Association, and complexities of SMS at major airlines), partnering with Embry-Riddle may provide an opportunity to continue to develop and mature requisite IASMS services, functions, and capabilities through research and development using Embry-Riddle as "surrogate" Part 121 SMS for SWS efforts,

together with other partners and stakeholders. Embry-Riddle and SWS are currently exploring various vehicles such as Space Act Agreements, reimbursable cooperative research agreements, contracts, etc. focused on several specific areas of collaboration.

SWS Members Establish New Space Act Agreement with Northrop Grumman
POC: CHRIS TEUBERT

System-Wide Safety (SWS) project researchers from the Intelligent Systems Division's Diagnostics and Prognostics group have established a non-reimbursable Space Act Agreement with Northrop Grumman this month. The Space Act Agreement enables mutual collaboration on prognostic model development, algorithm development, and the Prognostics Python (ProgPy) packages. Under this agreement, Northrop Grumman is contributing to the ProgPy software and providing access to degradation data to support prognostic model development during the next two years. The result of the ProgPy software contributions will be a more robust and capable software – helping users at NASA develop new prognostic technologies. The degradation data provided by Northrop Grumman will help the SWS project mature, validate, and extend their prognostic models in

support of a future In-time Aviation Safety Management System.

Transitional UAM Tabletop Exercise 2 Conducted
POC: IAN LEVITT

On Jan. 24-26, representatives from the Air Traffic Management – Exploration (ATM-X) project's

Users attending the tabletop exercise and a graphic from the NFLITE

Urban Air Mobility (UAM) Airspace Management team participated in a tabletop exercise at the National Aerospace Research and Technology Park (NARTP) in New Jersey. The NARTP is adjacent to the FAA's William J Hughes Technical Center (WJHTC). The

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purpose of the tabletop was to explore an initial end-to-end use case for the transportation of passengers between an urban environment and nearby controlled airport utilizing new electric vertical takeoff and landing aircraft. This is one of a spectrum of use cases being considered in NASA's ATM-X project in partnership with the WJHTC and industry partners. These use cases are being exercised in an immersive, integrated airspace simulation live-virtual-constructive environment, called the NASA/FAA Laboratory Integrated Test Environment, as part of an effort to learn how UAM operations can scale beyond the as-is National Airspace System and through the transition to high-tempo and highly automated operations of the future. The three-day event was attended in-person by a range of participants from the Department of Transportation, the FAA, the National Air Traffic Controllers Association (NATCA), and industry representatives. Multiple organizations within the FAA's Air Traffic Organization, Airports, Aviation Safety, and Office of NextGen attended and provided valuable insight and inputs into how to successfully execute and approve UAM operations. Support from Joby Aviation and Boeing added operator perspective, and NATCA provided deep operational and regulatory knowledge of airspace operations. Representatives from

the Advanced Air Mobility (AAM) project also participated. The NASA/FAA team invited the group to a regular joint test session, providing the opportunity for the tabletop participants to experience the use cases first-hand in the test environment.

SWS Participates in VABA Aerospace Days
POC: MICHAEL VINCENT

The System-Wide Safety (SWS) project hosted a booth at the 2023 Virginia Aviation Business Association's (VABA) Aerospace Days to kick off the 2023 Virginia General Assembly legislative session. VABA's Aerospace Days is an event that provides Virginian aviation businesses with an opportunity to network with state lawmakers and other businesses – traditionally hosting more than 450 attendees. The SWS project's booth was part of a legislative reception on Jan. 25 in downtown Richmond, where members of the business aviation

community, state legislators, and legislative staffers were in attendance. Governor Glenn Younkin was also in attendance and provided the keynote statement at the legislative reception. Visitors to the SWS booth were able to learn about the project's work developing In-time Aviation Safety Management Systems (IASMS) for emerging and autonomous aviation operations for future Advanced Air Mobility missions, commercial air carriers, and emergency response and public good missions. Visitors to the booth were also invited to experience SWS's unique virtual-reality experience which demonstrates how an IASMS for Advanced Air Mobility operations would work in an urban environment. SWS associate project manager Michael Vincent supported the booth and spoke to attendees. VABA is a non-profit organization that promotes the development of aviation business within Virginia.

Visitors to the booth were also able to experience SWS's unique virtual-reality experience which demonstrates how an IASMS for Advanced Air Mobility operations would work in an urban environment.

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UAM Researcher Gives Invited Lightning Round Talk on MBSE

POC: NIPA PHOJANAMONGKOLKIJ

On Jan. 29, Nipa Phojanamongkolkij, lead systems engineer for Urban Air Mobility (UAM) subproject within the Air Traffic Management – Exploration project, was invited to give an 18-minute lightning-round talk (similar to a TED talk) on an innovative systems engineering methodology at the International Council on Systems Engineering International Workshop 2023 in California. The UAM airspace subproject is conducting research that evolves UAM airspace towards a highly automated and operationally flexible system of the future. The complexity of UAM airspace, and its evolution through a series of transformative epochs, requires a planning tool to effectively organize, integrate, and communicate the research that will guide the evolution of UAM operations in the National Airspace System. The planning tool, called the UAM Airspace Research Roadmap, is being developed as a system engineering methodology leveraging Model-Based System Engineering (MBSE) and machine learning natural language processing capabilities. The talk, with a live demo, provided an overview of the natural language processing application for the requirement development process – enabling the UAM airspace subproject to meet its overarching research goals. This innovative application has proven a significant time savings (about 12 times) in requirement discovery and analysis over today's practices. For the UAM subproject, it could reduce one year of systems engineering work to only one day.

NASA Releases SWS-Developed VSCode-dL Software

POC: TERRY MORRIS AND MISTY DAVIES

In January, NASA officially released the VSCode-dL software tool available for users. The VSCode-dL software was funded and developed by the System-Wide Safety (SWS) project. VSCode-dL provides a modern development and formal verification environment for hybrid programs using the Prototype Verification System. It also provides an interface to Plaidypvs, a formalization of differential dynamic logic in the Prototype Verification System. It allows a user to specify hybrid programs, which are characterized by their mix of discrete and continuous dynamics, in a simple and intuitive manner. Users can also specify properties that programs should have, such as liveness or safety properties, and interactively use the verified deduction rules of dynamic logic to prove them. VSCode-dL provides levels of abstraction as well as coding for the user. This NASA Software Release is designated LAR-20311 1.

HDV SAO Team Reaches Breakthrough

POC: LOU GLAAB

The Scalable Autonomous Operations (SAO) Multi-Center Simulation Team within the Advanced Air Mobility project's High Density Vertiplex (HDV) subproject achieved a breakthrough regarding Vertiport Automation System integration. Since the HDV team is multi-center, enabling computers to communicate with each other requires extensive IT security measures. One critical computer was inadvertently omitted from a recent firewall port opening effort, leading to an inability to perform complete system integration. The team was able to review system requirements and identified an alternative laptop computer that could be leveraged while the IT security process proceeded. This allowed the team to start critical full-system integration testing and enable the SAO simulation team to remain on schedule to start testing on March 1.

SWS Attends January JIMDAT Meetings

POC: MICHAEL VINCENT AND LANCE PRINZEL

Representatives from the System-Wide Safety (SWS) project attended multiple meetings of the Joint

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Implementation Measurement Data Analysis Team (JIMDAT). The first meeting was held at United Airlines Headquarters in Chicago on Jan. 18–20. Michael Vincent, associate project manager for the SWS project, attended the meeting. JIMDAT monitors the implementation and effectiveness of Commercial Aviation Safety Team (CAST) safety enhancements and recommends modifications and changes to the CAST Safety Portfolio (https://www.cast-safety.org). JIMDAT, in conjunction with the Aviation Safety Information Analysis and Sharing program, also identifies emerging risks and additional areas of study. Vincent discussed the potential of leveraging the machine learning and data analytics from the SWS project with the JIMDAT members. The SWS project may be able to utilize machine learning algorithms to help the JIMDAT team identify safety events and their precursors in flight data and monitor and categorize safety reports to identify growing safety trends that are reported by flight crews. NASA continues working multiple safety enhancement actions in support of JIMDAT leveraging the SWS project's internationally renowned experts in aviation safety. The second meeting was at Boeing Headquarters in Virginia on Jan. 31-Feb. 1. Lance Prinzel, senior project technical advisor for the SWS project, attended the meeting. Prinzel represented SWS for commercial

aviation safety challenges and issues that were addressed at the meeting. The status of research safety enhancement for the In-Time Aviation Safety Management System (IASMS) and extension of a past NASA research safety enhancement (SE-207) examining safety benefits of head-up displays and angle-of-attack indicators were also discussed. Through several technical discussions with JIMDAT members, there were continued efforts to establish potential for leveraging machine learning and data analytics from the SWS project to help address Part 121 commercial aviation safety issues "in-time," and to leverage JIMDAT member expertise and access to data (i.e. the Aviation Safety Information Analysis and Sharing program). The proposed JIMDAT safety enhancement focus is on IASMS to include machine learning algorithms and natural language processing to help the JIMDAT team identify safety events and their precursors in flight data and monitor and categorize safety reports to identify growing safety trends that are reported by flight crews. NASA continues work on multiple safety enhancement actions in support of JIMDAT, leveraging the SWS project's internationally renowned experts in aviation safety. The SWS project participation in JIMDAT continues to ensure that NASA aviation safety expertise contributes to ensuring commercial aviation safety. It has also provided significant

opportunities to communicate to the aviation safety community the need and potential of IASMS to provide for the evolution of safety management systems requisite to ensuring a safe Info-Centric National Airspace System and the NASA "Sky for All" concept of operation. For more information, visit: https://www.cast-safety.org.

AAM Completes UML-2 ConOps Simulation
POC: KEN GOODRICH

On Feb. 1–2, Advanced Air Mobility (AAM) team members completed training and data collection for the "Piloted Urban Air Mobility (UAM) Maturity Level-2 (UML-2) Concept of Operations (ConOps) Simulation" (PUCS) study. The study took place in the Air Traffic Operations Lab at NASA's Langley Research Center in Virginia, included 10 pilots participating in a real-time simulation of initial commercial UAM flight operations (i.e. Urban UML-2), and was representative of early flight operations between an isolated vertiport pair in Class E or G airspace. Current Visual Flight Rules and procedures for non-towered airport operations were used. Consistent with this environment, pilots self-sequenced takeoffs and landings using a combination of external visuals, Common Traffic Advisory Frequency self-announcements, and Automatic Dependent Surveillance-Broadcast

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Figure 1. The PUCS Room

Figure 2. View from the #2 Aircraft

in traffic information. The study had two primary goals: 1) evaluation of the suitability of low-cost "UAM Flyer" cockpits (e.g. PUCS Room) for evaluating and developing the UAM ConOps in a flexible, real-time, multi-agent simulation environment; and 2) conducting a preliminary baseline assessment of the feasibility and limitations of initial UAM operations under current Visual Flight Rules and

regulations, while using currently operational technologies other than the basic electric vertical takeoff and landing aircraft. The simulated aircraft were an adaptation of the Revolutionary Vertical Lift Technology plus cruise reference configuration. Pilots with a range of experience levels (e.g. professional, private, and Part 107 certificates) from multiple NASA centers participated in the study. While data analysis is just beginning, the general impressions of the pilots included that the Flyers were suitable for the study, and that the multi-pilot environment was a useful compliment to more traditional simulation tools. The pilots also generally found the use of current, non-towered airport procedures reasonable for the operations assessed in the study (i.e., Visual Flight Rules operations between simply connected vertiports serving a homogenous fleet of electric vertical takeoff and landing vehicles). Sustained operations showed that takeoffs typically occupied the vertipad area for 30-40 seconds (Figure 2 shows the view from the #2 aircraft in the departure queue). Landings typically occupied the vertiport and approach area for approximately 60 seconds, though landing times were variable due to several factors including the absence of any flight deck guidance elements supporting the dynamic, decelerate-to-hover phase of landing, handling quality limitations of the aircraft

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simulation, and limited training time for the evaluation pilots.

PAAV Team Participates in ULI Roundtable

POC: MIWA HAYASHI AND ARWA AWEISS

On February 6–7, several researchers from the Air Traffic Management – Exploration project's Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject team virtually attended the University Leadership Initiative (ULI)'s Autonomous Aerial Cargo Operations at Scale Concept of Operations (ConOps) Roundtable. The roundtable consisted of experts from the University of Texas at Austin, Purdue University, the Massachusetts Institute of Technology (MIT), MIT Lincoln Labs, Morgan State University, and Cavan Solutions. The purpose of this group was to validate a research ConOps that characterizes five relevant operational scenarios to motivate, scope, and define research questions that the ULI team will address. The five scenarios are: 1) Intra-Appalachia Air Transport; 2) Intra-Appalachia Medical Delivery; 3) Interregional between Appalachia and the Dallas-Fort Worth Metroplex; 4) Metroplex Last Mile; and 5) Metroplex Passenger Transport. The PAAV researchers participated in the breakout discussion sessions for each scenario in this two-day roundtable activity. This benefited both the PAAV and

ULI teams by allowing the PAAV researchers to give inputs and gain insight that could inform both the ULI and PAAV ConOps.

ACERO Researchers Host Multiple Meetings at Ames

POC: JOEY MERCER AND MARCUS JOHNSON

The Advanced Capabilities for Emergency Response Operations (ACERO) project hosted multiple meetings this quarter at NASA's Ames Research Center in California. The first meeting, held Jan. 17, hosted four wildland firefighters from California Department of Forestry and Fire Protection (CAL FIRE)'s Unmanned Aircraft Systems program in the Airspace Operations Laboratory at NASA Ames. NASA researchers provided the CAL FIRE staff a tour and demonstration of the AOL's capabilities including traffic management tools and visualizations and a mixed-reality application featuring data previously collected at a CAL FIRE training exercise. The group discussed Unmanned Aircraft Systems Pilot kit technology transfer, as well as options for strengthening current and future collaborations. Researchers provided a high-level overview of ACERO's vision, to which the CAL FIRE visitors committed to bringing the topic to their agency's leadership. The second meeting was a Wildland Fire Interagency Working Group

tabletop session on remote sensing technologies on Feb. 7. The meeting was hosted by the NASA Aeronautics Research Institute. This ACERO-led working group is developing an interagency concept of operations for wildland fire to ensure consistency of operational priorities, technology adoption, and programmatic alignment for national needs. During the remote sensing tabletop, the group identified existing gaps and made recommendations on how to better integrate and use remote sensing technologies to improve situational awareness, increase firefighters' ability to perform their jobs more effectively and efficiently, and ultimately improve crew safety and public safety. The next interagency tabletop will be held May 2023 with a focus on wildland fire airspace management. Tabletop participants included the Army National Guard, Bureau of Indian Affairs, Bureau of Land Management, CAL FIRE, California National Guard, Cherokee Nation, Colorado Division of Fire Prevention and Control, Defense Innovation Unit, Department of the Interior, National Oceanic and Atmospheric Administration, Air Force Air National Guard, Department of Agriculture, Fish and Wildlife Service, U.S. Forest Service, Geological Survey and NASA.

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PAAV Participates at Large UAS m:N Working Group Meeting

POC: ARWA AWEISS AND CYNTHIA WOLTER

On Feb. 8, members of the Air Traffic Management – Exploration project's Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject team participated at the Large Unmanned Aircraft Systems (UAS) m:N Working Group Meeting. The team presented and led discussions virtually at the dedicated two-hour meeting. The definition of m:N is "m" remote pilots supervising "N" aircraft. More than 30 participants joined in with representatives from government and industry including the FAA, Ohio Department of Transportation, Alaska Department of Transportation, Reliable Robotics, Xwing, Northrop Grumman, Boeing/Aurora Flight, and Joby Aviation. Cynthia Wolter presented a summary of results from the recent knowledge elicitation tabletop activity that PAAV and the Transformative Tools and Technologies project's Human Autonomy Teaming Group jointly conducted recently. This activity was the fourth in a series of tabletop activities that PAAV has conducted. The first three tabletop activities focused on investigating challenges and solutions for seamlessly integrating 1:1 UAS operations into the National Airspace System. This fourth tabletop extended the investigation to identify the challenges and potential solutions for seamlessly integrating m:N remotely piloted cargo unmanned aircraft into the National Airspace System which will leverage work conducted to ensure 1:1 operations. PAAV team representatives David Thipphavong, Jordan Sakakeeny, and Miwa Hayashi concluded by guiding discussions about how meeting participants envision m:N operations to be conducted and presented an introduction to PAAV's challenge and solution matrix, which will be further discussed at future Large UAS m:N Working Group Meetings.

PAAV Presents to AFWERX Agility Prime at Langley

POC: ARWA AWEISS

On Feb. 8-9, AFWERX, a technology directorate of the Air Force Research Laboratory (AFRL) Agility Prime, visited NASA's Langley Research Center in Virginia as part of a multi-center tour. AFWERX Agility Prime is the Air Force's transformative vertical lift program with a goal of partnering with industry to advance a new class of air mobility systems. NASA Langley attendees included Sharon Monica Jones, Samantha McGill, and Steve Velotas. Representatives from the Advanced Air Mobility project, the System Wide Safety project, the Air Traffic Management – Exploration project, and the Revolutionary Vertical Lift Technology project provided brief presentations. Tod Lewis, technical lead for the Pathfinding for Airspace with Autonomous Vehicles subproject, provided a brief overview focusing on the traffic pattern integration work being performed at NASA Langley. Tours of other Langley facilities followed. Representing the AFWERX team were managers of Agility Prime and Autonomy Prime, as well as other fellows in various disciplines (e.g., air traffic control, weather, computational fluid dynamics, and small unmanned aircraft systems). Interest was also expressed in NASA Langley's Remote Operations for Autonomous Missions facility supporting the High Density Vertiplex subproject.

DIP Contrail Avoidance Work Proposal Approved for HECC Access

POC: SWATI SAXENA

The NASA Advanced Supercomputing Division's High-End Computing Capability (HECC) has agreed to provide the Air Traffic Management – Exploration project's Digital Information Platform (DIP) subproject computational resources on their cluster for 2023 to run and evaluate contrail detection, prediction, and avoidance models being developed within and outside NASA as part of Code TN's "AI Expansion" project. The DIP team is working on developing a sustainable aviation flight planning service to avoid contrails. This HECC resource

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will also provide the required infrastructure support and data science expertise.

PAAV Participates at the 2023 AirCargo Conference

POC: JORDAN SAKAKEENY AND ARWA AWEISS

On Feb. 12–14, the Air Traffic Management – Exploration project's Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject participated at the 2023 AirCargo Conference in Nashville. Jordon Sakakeeny and Tod Lewis represented the PAAV team and each learned more about how cargo moves via multiple modes, including air, and the issues facing the industry. The conference was hosted by three primary organizations: the Airforwarders Association, Airport Council International – North America, and Air and Expediated Motor Carriers Association. These companies organize and facilitate cargo movement and work with a combination of shippers, trucking companies, airlines, and others who are responsible for the actual cargo movement. The PAAV team shared potential PAAV concepts and research as well as soliciting industry feedback. Representatives from Alaska Airlines are interested in utilizing increasingly autonomous air cargo aircraft due to Alaska's unique geographic considerations and high utilization of regional cargo aircraft. One major topic of discussion at this conference was the increased growth

of cargo volume at large airports that has led to increased congestion – especially at the cargo terminals where cargo is exchanged between planes and trucks. The Airforwarders Association produced a 65-page white paper on the topic of air cargo congestion titled "Safeguarding the Future of Air Cargo."

AAM National Campaign IAS Team Completes Spiral-2A Flight Testing

POC: ADAM YINGLING AND WANESSA PRIESMEYER

On Feb. 15, the Advanced Air Mobility (AAM) project National Campaign subproject's Integration of Automated Systems (IAS) team executed the first flight test of the IAS Spiral-2 flight test campaign, building on the success of the IAS Spiral-1 tests conducted late last year. For this flight test the Sikorsky Optionally Piloted Vehicle (OPV), a UH-60 Blackhawk helicopter developed with the Defense Advanced Research Projects Agency (DARPA) as part of the Aircrew Labor In-Cockpit Automation System program, was flown utilizing the IAS middleware software to execute a four-dimensional trajectory (4DT). The testing demonstrated that the OPV was successful in flying the specified 4DT flight path within conformance limits. This is an important step to pave the way for the subsequent flight tests in which the IAS middleware will command the OPV and the Sikorsky

Autonomous Research Aircraft (SARA) in two-ship operations. The flight test incorporated NASA personnel from National Campaign's IAS and Airspace Test Integration teams, as well as from the Aircraft Flight Contingency Management (AFCM)'s Flight Path Management (FPM) team. Participation also included Sikorsky, DARPA, and the Air Force's Agility Prime program. Overall, the combined team included 16 personnel. The next flight test is scheduled for May 2023 and will be the first integration of FPM and AFCM's Hazard Perception and Avoidance algorithms onto SARA. Once those algorithms are verified, OPV will be incorporated into the testing as the "intruder" used to evoke a response from the algorithms under test conditions.

PAAV Presents to EPFD Team

POC: JORDAN SAKAKEENY AND ARWA AWEISS

On February 16, Jordan Sakakeeny of the Air Traffic Management – Exploration project's Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject met with representatives from the Electrified Powertrain Flight Demonstration (EPFD) project within NASA's Integrated Aviation Systems Program to present current air cargo operations analysis work. This work leverages data from Sherlock, the FAA, and the Bureau of Transportation Statistics (BTS) to provide insight into current

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air cargo operations – both at the national scale with large jets and at the regional scale with turboprop aircraft. As the current EPFD use case is a short-haul, regional-type flight, there are several areas of overlap between the EPFD and PAAV use cases in the regional air cargo market. EPFD has been using Sherlock and BTS data to provide insight into passenger operations and has been planning to delve into cargo operations in the future. Research on cargo operations from the PAAV subproject can be leveraged for the EPFD project resulting in starting new research efforts from EPFD. The PAAV team will continue to attend a weekly Integrated EPFD/Sustainable Flight Demonstrator Testbed support meeting to keep apprised of efforts in EPFD and identify areas of overlap.

SWS Researchers Visit American Airlines to Outline Collaboration

POC: KYLE ELLIS AND MICHAEL VINCENT

On Feb. 16–17, researchers and managers with NASA's System-Wide Safety (SWS) project met with leaders and program managers from American Airlines' Safety and Flight Operations groups in Dallas. The meeting was held at American's headquarters and included experts from each organization, who discussed key areas of collaboration to advance safety and efficiency in flight operations for commercial carriers such as American. Together, they identified several opportunities and outlined specific work packages that will become part of a joint effort to advance safety management systems and expand efficiency of traditional aviation in a transformed airspace. The work areas identified are key deliverables to be incorporated into the SWS project's future research portfolio focused on In-time Aviation Safety Management System for commercial aviation operations. This work is paramount to transforming the existing airspace system to incorporate Advanced Air Mobility operations safely and equitably with the existing transportation markets in the National Airspace System.

ATM-X Hosts DOT and ITSA at NASA Ames

POC: SHIVANJLI SHARMA

On Feb. 21, the Air Traffic Management – Exploration (ATM-X) project hosted members from the Department of Transportation (DOT) Office of Research and Technology (OST-R) along with leadership members from the Intelligent Transportation of Society of America (ITSA) at NASA's Ames Research Center in California. The group discussed and engaged on a variety of topics regarding the Advanced Air Mobility Ecosystem in the context of developing a crosscutting multimodal transportation system for the United States. Participants included OST-R's director of the Highly Automated Systems Safety Center of Excellence, OST-R's senior scientist for Integration and Interoperability, ITSA's chief operating officer, ITSA's vice president for Innovative Mobility and Emerging Technology, and ITSA's chair of the Digital Infrastructure Working Group. The

SWS met with American Airlines to discuss key areas of collaboration to advance safety and efficiency in flight operations.

DOT representatives meet with the ATM-X team

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visit included a tour of key NASA Ames research facilities developed to support research, as well as simulation and data collection, needed to address research questions of airspace integration, vehicle automation, and the intersection of airspace frameworks with ground considerations and modes of transportation. Topics of discussion included the need to develop a national reference architecture that leverages both ground and Advanced Air Mobility architecture concepts as well as mechanisms for continued collaboration.

SWS Participates in DARPA ARCOS Meetings

POC: MALLORY GRAYDON, PAUL MINER AND NATASHA NEOGI

System-Wide Safety (SWS) project researchers participated in meetings supporting the Defense Advanced Research Projects Agency (DARPA)'s Automated Rapid Certification of Software (ARCOS) project this quarter. The first meeting was the Quarter 1 Principal Investigator's Meeting at the headquarters of the hosting organization, the Software Engineering Institute, in Pittsburgh on Jan. 24-25. SWS's Mallory Graydon and Natasha Neogi participated in the meeting remotely while Paul Miner participated in person. ARCOS participants demonstrated

assurance case-related tooling they are constructing. The SWS team used their expertise in safety assessment and assurance to provide feedback that will help DARPA staff determine whether ARCOS is on track to deliver rapid, low-cost means to assess and assure the safety and security of high-consequence software systems following changes. While ARCOS aims to reduce the cost of certifying software-intensive military systems, the tools and techniques it results in may have applications to software used in aviation and spaceflight applications. A second set of meetings was held Feb. 10-24 in seven separate two-hour sessions. ARCOS participants demonstrated assurance case-related tooling they are constructing. Graydon, Miner, and Neogi again participated – providing their expertise in supporting ARCOS. For more information, visit: https://www.darpa.mil/program/automated-rapid-certification-of-software.

AOSP and ATM-X Meet with Hillwood on sUAS Collaboration Opportunities

POC: SHIVANJLI SHARMA

On Feb. 22, members from AOSP visited and met with the Hillwood Properties and Alliance Texas team to discuss and engage on topics regarding testing of small Unmanned Aircraft Systems (sUAS) use cases in a

representative environment. The AOSP team included program office staff, members of the Air Traffic Management – Exploration (ATM-X) project office, researchers from ATM-X's Extensible Traffic Management subproject, and the Advanced Air Mobility project's High Density Vertiplex subproject teams. The visit and discussions were hosted by the executive vice president of strategic development and innovation for Hillwood, as well as the senior vice president of aviation business development for Alliance Air Services and Alliance Aviation Services at Hillwood Offices in Fort Worth. The visit included a discussion of past testing efforts between Hillwood, NASA, and other industry participants at the Mobile Innovation Zone – a test site that enables testing of airborne logistics and intermodal supply chain concepts. Visit the following website for additional information: https://www.alliancetexasmiz.com/. Additional topics included potential collaboration on research needed to enable regular and scalable sUAS operations when multiple operators may be providing sUAS services in the same geographical region. Next steps include several follow-on meetings to further understand use cases and concepts that can be collaboratively explored, as well as potential avenues for engaging in a future partnership.

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AOSP Visits the Choctaw Nation of Oklahoma's EATC to Discuss Collaboration Opportunities

POC: SHIVANJLI SHARMA

On Feb. 23, representatives from AOSP visited the Choctaw Nation of Oklahoma's Emerging Aviation Technology Center (EATC) located in Atoka County, Oklahoma. Representing the AOSP team included program office staff and members of the Air Traffic Management – Exploration project office, including researchers from the Extensible Traffic Management subproject and the Advanced Air Mobility project's High Density Vertiplex subproject teams. The visit and discussion were hosted by the executive director of advanced technology initiatives for the Choctaw Nation. The visit

AOSP Representatives at the EATC

included a tour of the EATC, which maintains more than 44,000 acres (17,800 hectares) of land supporting innovative testing for emerging manned and unmanned aviation entrants. The test site's history as part of the FAA's Unmanned Aircraft Systems (UAS) Integration Pilot Program and BEYOND program has positioned it be a strong candidate for future sUAS testing given the low-risk environment and the ability to conduct studies to inform methods of compliance for Beyond-Visual-Line-of-Sight sUAS flights. In addition to dialogue around leveraging the test site for a potential testing partnership, NASA and Choctaw Nation representatives also discussed key public-good use cases such as medical supply delivery as well as the potential for a Science, Technology, Engineering, and Mathematics (STEM) outreach program focused on sUAS and Advanced Air Mobility.

Next steps include several technical interchange meetings to further understand use cases and concepts that can be collaboratively explored as well as potential avenues for engaging in a future partnership.

NASA Ames Aeronautics Directorate and ATM-X Visit Joby Aviation

POC: WILLIAM CHAN

On Feb. 28, members from the Aeronautics Directorate at NASA's

NASA team visiting Joby Aviation

Ames Research Center in California and the Air Traffic Management – Exploration (ATM-X) project visited Joby Aviation. The purpose of the visit was to provide NASA participants the opportunity to learn more about the Joby aircraft and its capabilities and to continue discussions related to NASA/Joby collaboration. The visit included a viewing of the Joby experimental aircraft and aircraft fleet, a tour of their manufacturing facility, and the opportunity to fly their flight simulator. The visit concluded with a discussion of the upcoming joint NASA/Joby simulation utilizing Future Flight Central at NASA Ames.

ACERO WAM Team Participates in Prescribed Burns Training

POC: MARCUS JOHNSON

In February, members from the Advanced Capabilities for

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Emergency Response Operations (ACERO) project's Wildfire Airspace Management (WAM) team participated in the U.S. Forest Service Aerial Ignition Academy prescribed burn training. The team shadowed the Unmanned Aircraft System (UAS) crews training in the field and put the ACERO project's UAS pilot kit through its paces as the trainees flew their prescribed burn practice flights. The UAS pilot kits provided drone operators awareness of nearby aircraft – making it safer to conduct these kinds of burns. Members of the WAM team are shadowing four units of trainees each using a UAS pilot kit. The crews are spread out in three states: Mississippi, South Carolina, and Florida. Each crew has been able to remotely operate the drones and prescribed burns. ACERO's WAM research team is collecting feedback from the users and making observations on the ways crews are using their UAS pilot kits.

SWS Human-Machine Teaming NRA Year 3 Closeout and Midterm Review

POC: NATASHA NEOGI

The System-Wide Safety (SWS) project's NASA Research Announcement (NRA) topic "Assuring Increasing Autonomous Systems with Non-Traditional Human-Machine Roles" conducted its Year 3 closeout review for the
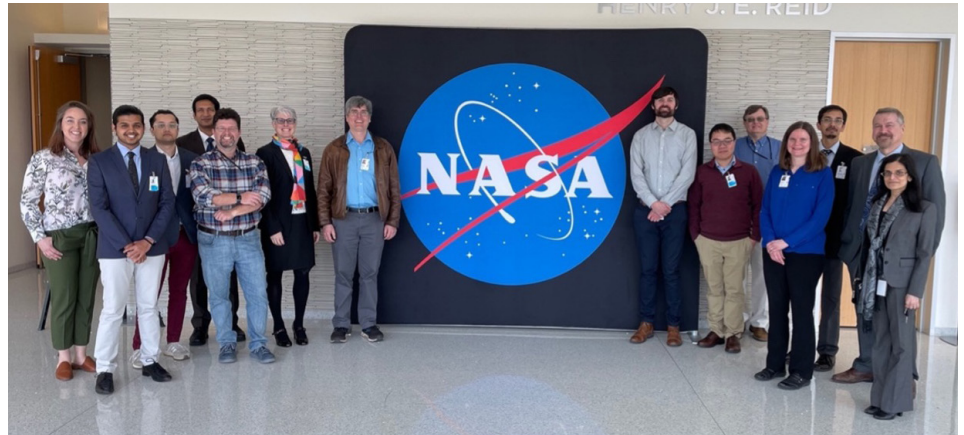
SWS Human-Machine Teaming NRA - Year 3 Closeout and Midterm Review

Penn State University and Collins Aerospace teams, and midterm review for the Massachusetts Institute of Technology (MIT) team, on Feb. 28-March 1. All three performing teams presented an in-person summary of their progress on the Urban Air Mobility (UAM) case study. Amy Pritchett of Penn State presented a summary of efforts regarding the UAM Concept of Operations and task modelling in the Working Models that Compute framework, with a specific focus on a short-range cargo delivery service in a rural area (e.g. a delivery service) where vehicle (battery) health monitoring and workload across multiple role allocations were examined. The team from Collins, led by Jen Davis, aggregated the work they performed throughout the grant into a framework supported by a toolchain. They detailed and demonstrated their approach whereby they: 1) specified systems

in the Architecture Analysis and Design Language modelling framework; 2) modelled and trained autonomous agents via reinforcement learning techniques for UAM-specific contingency conditions in the Soar Cognitive architecture framework; and 3) verified these learned agents in the NuXMV model checker. Nancy Leveson's MIT team presented their work on the Systems Theoretic Process Analysis (STPA) methodology. They focused on how STPA could be applied to capture inimical human-machine interactions as well as develop and evaluate architectures with tradeoffs between ranked requirements, assumptions, and constraints. Natasha Neogi, the NASA technical point of contact, along with Paul Miner and Jon Holbrook, arranged for each team to engage interactively during the question-and-answer sessions – enabling an exchange of ideas. Sessions were

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attended by external subject matter experts from the FAA and the Air Force Research Laboratory, who provided valuable feedback.

UAM Completes AIS Experiment Review with Joby Aviation

POC: SAVITA VERMA

On March 2, the Air Traffic Management – Exploration project's Urban Air Mobility (UAM) Airspace Management subproject team completed a joint Air Traffic Management Interoperability Simulation (AIS) experiment review with Joby Aviation. The NASA/Joby Aviation Human-in-the-Loop Simulation will develop and test notional air traffic control UAM pilot communications and procedures for current-day and mid-term UAM operations in the Dallas-Fort Worth International Airport area, plus assess the information requirements, workload, and scalability/feasibility of candidate air traffic procedures for UAM operations. The multi-day simulation, informed by Joby use cases, will be conducted at NASA's Future Flight Central in mid-September 2023.

Formal Requirements Elicitation Tool Used at Collins Aerospace and Galois

POC: ANASTASIA MAVRIDOU

As of March 3, the System-Wide Safety project's Formal Requirements Elicitation Tool (FRET) has been successfully used in two projects by Collins Aerospace and Galois. As part of VALU3S consortium, FRET was used by Collins Aerospace, Ireland in collaboration with Maynooth University to elicit and formalize the requirements of an aircraft engine software controller model. Additionally, FRET was also used in the High Assurance Rigorous Digital Engineering for Nuclear Safety (HARDENS) project by Galois to specify and analyze requirements for a safety-critical demonstration system for the Nuclear Regulatory Commission.

NASA Ames Hosts KARI Visit

POC: WILLIAM CHAN

On March 6-7, representatives from the Korean Aerospace Research Institute (KARI) and the Korean Ministry of Land, Infrastructure, and Transportation (MOLIT) in South Korea visited NASA's Ames Research Center in California as part of a joint NASA/KARI collaboration. Discussions were held on the three tasks outlined in the collaboration agreement: 1) the Advanced Air Mobility National Campaign and the K-Urban Air Mobility (UAM) Grand Challenge collaboration; 2) simulation requirements and evolution; and 3) Advanced Air Mobility National Campaign and K-UAM Grand Challenge flight demonstration information exchange. The NASA team provided briefings on the National Campaign-1, UAM airspace research, and High Density Vertiplex subprojects. Subsequently, the KARI team provided multiple

Group photo of South Korean Visitors

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KARI visitors touring Future Flight Central

presentations about K-UAM Grand Challenge. The representatives from KARI and MOLIT also toured the Airspace Operations Lab, Future Flight Central, Aerospace Cognitive Engineering Lab Rapid Automation Test Environment Laboratory, and Vertical Motion Simulator facilities. Next steps include a meeting between NASA and KARI to discuss takeaways from the workshop, refine the work in each task, and identify a date and location for a future workshop as part of fulfilling deliverables in the NASA/KARI agreement.

UAM CNS Team Completes Flight Test CDR at NASA Glenn

POC: RAFAEL APAZA

On March 14, the Communications, Navigation, and Surveillance (CNS) team supporting the Air Traffic Management – Exploration project's Urban Air Mobility (UAM) subproject successfully completed its commercial cellular communications flight test Critical Design Review (CDR). The

design review process included an aircraft hazard analysis, electronic equipment installation review, equipment power configuration, electronic signal configuration, equipment rack configuration, and radio antenna deployment on the aircraft. Flight trials using the PC-12 aircraft at NASA's Glenn Research Center in Cleveland are scheduled to start in early-May 2023.

NASA and FAA Sign UTM RTT Joint Management Plan Version 2

POC: MIN XUE

On March 15, the Air Traffic Management – Exploration project's Extensible Traffic Management subproject team recently signed an updated version of their Unmanned Aircraft Systems Traffic Management (UTM) Research Transition Team (RTT) Joint Management Plan with the FAA. The Joint Management Plan Version 2 establishes the scope of collaboration and identifies impactful Research Transition Products that can address critical community needs for enabling Beyond Visual Line of Sight. This Joint Management Plan confirms NASA's commitment to developing and continually maturing the federated UTM system and supporting multi-vehicle Beyond Visual Line of Sight operations. After the final approval, the subproject added new task plans to start working on the three

Research Transition Products. Four Level 2 milestones and one Level 1 milestone were created accordingly.

SWS Briefs NASA Agency Program Management Council

POC: MISTY DAVIES

Misty Davies, manager of the System-Wide Safety (SWS) project, provided a presentation at the Agency's Program Management Council (APMC) held March 16. The APMC consists of senior managers representing each of NASA's mission directorates. The presentation was on the impacts of the Aeronautics Research Mission Directorate (ARMD)-funded Verification and Validation research. The intent of the presentation was to share knowledge about techniques that might be valuable across the agency and to inform NASA leadership of plans for ARMD-funded research. There were 63 attendees at the meeting, including representatives from all the NASA centers.

DIP Hosts Workshop with Salesforce MuleSoft Team

POC: SWATI SAXENA

On March 17, the Air Traffic Management – Exploration project's Digital Information Platform (DIP) subproject team hosted a workshop and whiteboarding session with Salesforce MuleSoft team. The purpose of the workshop was to learn more about Salesforce's Anypoint

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Platform and other products, as well as exploring the possibility of using their products in the reference implementation of the DIP platform. There is considerable overlap between their technology and capabilities the DIP platform has developed so far. The exercise of comparing the DIP technology stack with a complementary commercial product gave the DIP team a good understanding of the state of the art of the technology, as well as the standards used in the software development for Application Programming Interfaces, micro-services architecture and authorization, and authentication processes. The discussion was fruitful and will help the DIP team define the technology transfer elements for the Salesforce platform. The next step is to follow-up with the Salesforce Mulesoft team with remaining technical questions and learn about managing, securing, and running multiple Application Programming Interfaces from anywhere.

SWS Completes Usability Study of SFC Interfaces

POC: LYNNE MARTIN

On March 17, a team from the System-Wide Safety (SWS) project successfully concluded a cross-center usability study. The team tested the informativeness and usability of two example interfaces. One of the interfaces was hosted by NASA's Langley Research Center in

Virginia and the other by its Ames Research Center in California with the research team working from both centers to conduct the study at Ames. The two interfaces presented Services, Functions, and Capabilities (SFCs) developed by team members under different fleet manager flight planning scenarios. Participants were asked to interact with the interfaces, extract information from them, and discuss their decision-making reasoning using the tools. Sixteen participants completed the study. The results and conclusions from this work will be presented at AIAA Aviation 2023.

DIP Hosts University Challenge #2

POC: TIMOTHY SCOTT

The Air Traffic Management – Exploration project's Digital Information Platform (DIP) subproject team is working with DrivenData to host a public competition for university teams to develop a machine learning model to predict airplane pushback times. The competition is split into two "arenas." The first is an open arena which is open to the public, for anyone to participate. There is no prize for this arena, but DrivenData's competition platform provides easy access to a 137-gigabyte dataset from 10 U.S. airports which can be used for research and experimentation. It can also be used to practice for the prescreened arena, which is

open to teams affiliated with U.S. universities, and has a total prize purse of $50,000. Both competitions conclude April 17 and have attracted a total of 263 participants thus far. DrivenData's platform provides a live-updating leaderboard from the open arena, showing the gradual improvement of accuracy with each model submitted: https://www.drivendata.org/competitions/182/competition-nasa-airport-pushback-prescreened/leaderboard/. Both competition arenas can be found here: https://www.drivendata.org/competitions/group/competition-nasa-airport-pushback/ In addition to sending emails to mailing lists, NASA has also publicized this competition via social media: https://www.facebook.com/631116826990989/posts/576407354531082, https://twitter.com/NASAaero/status/1626366494031417345?s=20.

UAM Team Publishes Research Roadmap Version 2.0

POC: KEVIN WITZBERGER

The Air Traffic Management – Exploration project's Urban Air Mobility (UAM) Airspace Management subproject team published Version 2.0 of their Research Roadmap in March. The UAM Airspace Research Roadmap was created to be an important tool for the execution of NASA's research during the next ten years, with the

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goal of evolving UAM airspace operations to UAM Maturity Level 4. It provides a basis for prioritizing and coordinating research efforts and for integrating results building towards NASA's research goals. The Research Roadmap also has the potential to serve as a focal point for ongoing and continuous deliberation, as has been the case during its development. It naturally attracts questions and feedback that are beneficial to overall understanding, which is key to NASA's leadership in defining the airspace of the future. The Research Roadmap Version 2.0 consists of updates from members of the Advanced Air Mobility project's Ecosystem Working Group.

SWS Researchers Present to Boeing and the FAA

POC: GUILLAUME BRAT, DIVYA GOPINATH AND CORINA PASAREANU

On March 20, System-Wide Safety (SWS) researchers Divya Gopinath and Corina Pasareanu presented their work on test coverage for deep neural networks to the FAA. The presentation was organized by Huafeng Yu of Boeing as part of Boeing's effort to help the FAA create standards for the certification of systems that are machine-learning enabled. The audience consisted of George Romanski, the FAA's chief scientist for software; Trung Pham, the FAA's chief scientist for artificial intelligence); and Srini

Mandapalu and Joseph Pastore for the FAA. Boeing representatives from their artificial intelligence technology office, defense space and security division, and regulatory affairs office were also in attendance. This presentation supports both the milestones NASA has with Boeing under the One-Boeing-NASA effort and the milestones under the Research Transition Team effort with the FAA. Gopinath and Pasareanu presented techniques related to the analysis of deep neural networks using typical software engineering practices such as testing. Test suite adequacy measured by coverage metrics is an important indicator of the effectiveness of testing. They also discussed popular structural coverage metrics proposed in literature, and then presented their tool, DNNCov, that evaluates test suites using popular structural coverage metrics and compares the metrics with respect to their sensitivity to functional diversity and defect detection ability of the tests. They showed that existing metrics which only measure the coverage of structural entities of a deep neural network suffer from the limitations of not having a connection with intended behavior or not being traceable back to requirements. They also presented their current work on rule-based testing of neural networks (to Appear in D'SyMLe 2023 workshop) in which, given a representative set of labelled data, they mine rules abstracting input-output behavior;

both correct/intended and incorrect/unintended. The rules are in terms of neuron constraints and thereby help make the connection between the structural entities of the deep neural network and model behavior. They demonstrated the usage of these rules are coverage obligations for test suites. In Feature-Guided Analysis of Neural Networks (to appear in FASE 2023), they also analyzed a deep neural network model in terms of human understandable domain-specific features by mining rules corresponding to them. They briefly discussed potential uses in requirement analysis, verification, debugging, runtime monitoring and conformance to Operational Design Domain requirements. The talk was very well received. Pham thanked them as the topic covered is extremely relevant to his effort to establish certification standards for machine learning-enabled systems. Romanski was also very enthusiastic and provided detailed feedback for future research directions

DIP/SFNP Conduct TIM on Contrails Mitigation

POC: GEORGE SZATKOWSKI

On March 20-24, the Air Traffic Management – Exploration project's Digital Information Project (DIP) subproject team held a Technical Interchange Meeting (TIM) on contrail mitigation last week. The DIP team's Sustainable Flight National Partnership (SFNP)

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Operations-2 team hosted the meeting which included a team from the Massachusetts Institute of Technology (MIT)'s Laboratory for Aviation and the Environment. The Operations-2 team members provided a briefing on the DIP subproject and shared the technical goals of the Sustainable Oceanic Airborne Re-Routing flight deck service being developed under the SFNP Operations-2 demonstration. MIT stated that the DIP platform could provide the missing piece for them to offer their contrail mitigation models to the community and they will seek a formal NASA partnership through the upcoming release of the "Announcement of Collaborative Opportunity." The team from NASA's Langley Research Center in Virginia presented their research using the Satellite Cloud and Radiation Property retrieval System (SatCorps) model to improve flight altitude meteorological estimates by fusing satellite sounding data sets. MIT was very interested in this work and believe the improved wind prediction model could help them better correlate satellite contrail observations with aircraft flight tracks. MIT presented their research aimed at improving the state of the art in contrail dispersion and lifetime modeling and the associated implications to the radiative forcing estimations. Sebastian Eastham, an MIT research scientist, shared his insights related to improving ice plume modeling

by incorporating the Ostwald ripening effect. This work will directly lead to better climate impact assessments. MIT also briefed their flight campaign experiments being conducted with Delta Airlines to avoid Ice Super-Saturated Regions based on satellite imagery of observed contrail regions over the continental United States. The Operations 2 team will continue to engage with MIT and explore areas of opportunity which can support SNFP demonstrations and increase the Technology Readiness Level of the contrail mitigation solution.

HDV Conducts Activities to Support Upcoming SAO-PAO Flight Tests

POC: LOU GLAAB

The Advanced Air Mobility's High Density Vertiplex (HDV) subproject team initiated various activities

this past quarter to support the upcoming Scalable Autonomous Operations Prototype Assessment Operations (SAO-PAO) flight test activities scheduled for later in Fiscal Year 2023. On Jan. 9-13, the team conducted surveillance testing in support of Beyond Visual Line of Sight (BVLOS) efforts at NASA's Langley Research Center in Virginia. Having a comprehensive view of the air traffic in the vicinity of NASA Langley is considered essential for safe, effective, small-Unmanned Aircraft System (sUAS) operations. After continued integration and checkout sessions with Anra and NASA's HDV personnel, a major breakthrough was realized: through focused testing and collaboration, it was identified that transitioning the lightweight surveillance and target acquisition radar-2 (LSTAR-2) from UAS mode, originally recommended by SRC, to General Aviation mode
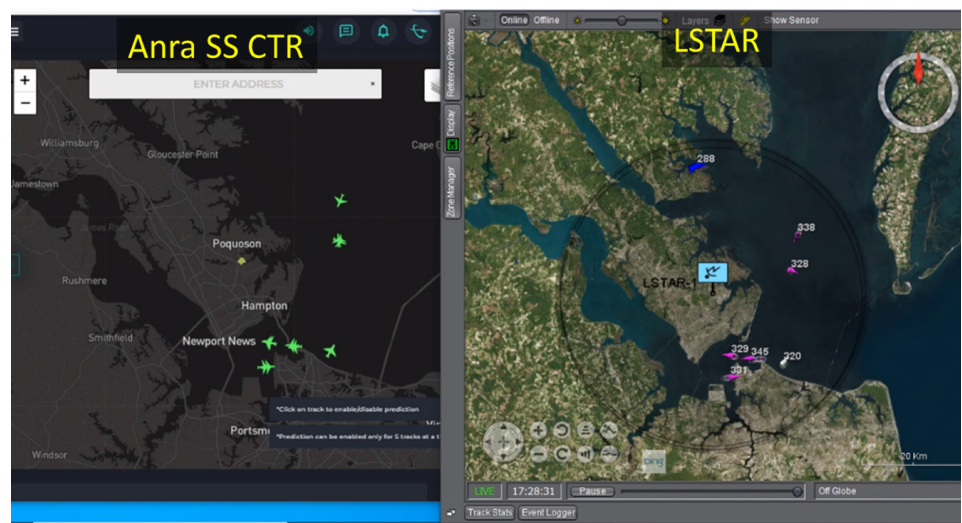
Displays of Anra and LSTAR

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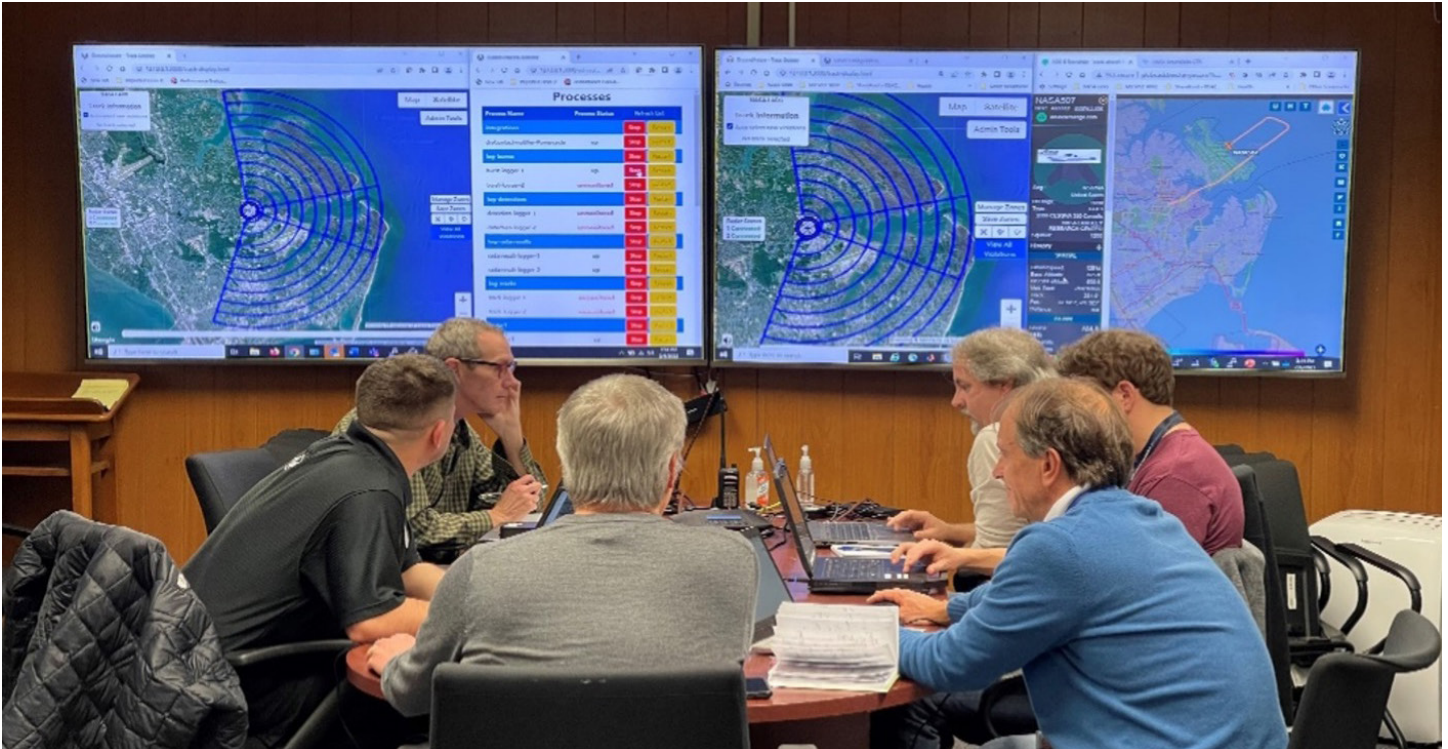
Surveillance Testing Team at NASA Langley

greatly reduced the ground clutter generated from the LSTAR radar. The reduction of clutter greatly contributed to Anra SS CTR (an airspace management software platform) surveillance integration and testing. As illustrated in the figure below, aircraft tracks in Langley's vicinity were established on the LSTAR Graphic User Interface that were accurately portrayed on the Anra SS CTR. In addition, effective fusion with Automatic Dependent Surveillance-Broadcast (ADS-B) surveillance was also demonstrated. One track to the north of Langley has just initiated on the LSTAR and was not portrayed on the Anra SS CTR as

could be expected. Remaining work involves cleaning up some track identification and management and track labels along with efforts to refine fusion of ADS-B, Flight Alarm (FLARM), and radar.

On Jan. 27, Jake Schaefer, the HDV subproject Flight Operations team lead within the Advanced Air Mobility project, conducted the final review for the SAO-PAO Flight Tests (Flt) to the Eastern Region Aviation Review Board. The overarching objective of the SAO schedule work package was to develop and evaluate concepts, prototypes, procedures, and technologies supporting operations at increased scale from a verti-

port. The HDV subproject effectively uses sUAS as surrogates for larger Urban Air Mobility aircraft. Testing includes coordinated and complementary simulation and flight techniques. SAO-PAO-Flt greatly expand sUAS operational capability at NASA and continue the transition from limited within visual line of sight operations towards BVLOS operations. This provides expanded testing capabilities and facilitates NASA technology transfer. Several significant milestones are included within SAO-PAO-Flt: 1) relocation of the Range Safety Officer to within the Remote Operations for Autonomous Missions UAS operations center and 2) the transition of ground

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control station operators to be pilots in command through focused training along with the removal of the visual/safety pilot in the field. A final step planned for the subsequent SAO-BVLOS flight test will seek to remove the visual observer in the field. While much work remains to be accomplished, the steps to be achieved in SAO-PAO Flt greatly expands sUAS operational capabilities at NASA, continues contributions to the HDV subproject research objectives, as well as setting the stage for planned sUAS BVLOS operations.

On Feb. 6, the HDV team completed the Radar 2–4 flight test using NASA's Lancair UC-40 aircraft. The objectives of the Radar 2-4 test were: 1) evaluate the LSTAR performance with the recent software upgrade; 2) assess the Dynetics GA-9120 radars performance to track general aviation aircraft out to 5 nautical miles and engage Dynetics onsite support; and 3) test the Anra SS CTR surveillance fusion integration and display system. The Radar 2-4 flight test is the seventh overall flight dedicated to the checkout of the surveillance systems being implemented at NASA Langley to enable BVLOS operations. The ground-based surveillance system includes ground-based ADS-B, ground-based FLARM, SRC LSTAR, and 4) Dynetics GA-9120 panel radars. The GA-9120s are lower-cost units procured with HDV seed resources in 2020 providing partial azimuthal coverage. The LSTAR was

procured under NASA's UAS Traffic Management project and is on loan from NASA's Ames Research Center in California. Good performance was observed overall for the integrated surveillance system. Analysis of results are underway with further work examining apparent interference issues with the GA-9120s as well as potential altitude errors with the LSTAR.

Following these activities, the HDV team received a formal response from the FAA regarding BVLOS safety case. The response indicated that the safety case effectively mitigated risks associated with the planned operations and that NASA should submit the application for a BVLOS Certificate of Authorization as soon as possible. The expectation is to have the application submitted in February with an anticipated certificate acquired June 2023. Following the completion of the SAO-PAO simulation in March, the HDV team initiated checkout flights for the SAO-PAO flight test on March 21–24. During these tests two vehicles (N557NU and N559NU) were flown with good results. Two additional vehicles were ready for checkout on March 31. A total of four vehicles are required to perform Phase-1 testing planned to start May 5. Phase-1 will require three vehicles for the planned test conditions, with one vehicle being a ready spare. SAO-PAO will include five vehicle operation in Phase-2. Vehicle

and scenario checkout will continue through March and April 2023.

SWS Presents at ICAO Safety Management Workshop

POC: <u>KYLE ELLIS</u>

On March 22, Kyle Ellis, deputy project manager of the System-Wide Safety (SWS) project gave an invited presentation to the Safety Intelligence and Safety Performance Management Workshop organized by the Asia and Pacific Office of International Civil Aviation Organization (ICAO). The presentation detailed work being done on the In-time Aviation Safety Management System (IASMS) concept within the SWS project and was well received. An invitation was extended to present work on these concepts at future events. This workshop was conducted by the Safety Management Unit – Air Navigation Bureau of ICAO and held at the ICAO Asia and Pacific Regional Office in Bangkok. On March 27, Ellis was also invited to present at the ICAO Air Navigation Commission (ANC). His presentation addressed advanced safety management systems to safely modernize and transform the global aviation industry. The key challenges faced by the ANC include maintaining and improving aviation safety and air navigation efficiency while integrating increased traffic into the current aviation infrastructure,

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introducing advanced systems, as well as proactively identifying risks and devising mitigation measures in accordance with the ICAO Global Aviation Safety Plan and the Global Air Navigation Plan. NASA's concept of an IASMS and the IASMS development roadmap outlined by the Flight Safety Foundation is being presented as a clear vision to evolve current practices and address these key challenges. The ICAO ANC consists of 19 commissioners representing state civil aviation authorities from around the planet. With direct influence on international policy, the ANC considers and recommends Standards and Recommended Practices and Procedures for Air Navigation Services for adoption or approval by the ICAO council. The ANC will review the IASMS concept and roadmap presented by NASA and the Flight Safety Foundation to inform its technical work program and recommend updated Standards and Recommended Practices for Annex 19 on safety management.

UAM Fast-Time Simulations Completed

POC: SEUNGMAN LEE

On March 27, researchers from the Air Traffic Management – Exploration project's Urban Air Mobility (UAM) subproject completed fast-time simulations, with and without a tactical conflict management system on, to evaluate the impact of tactical conflict management with a set of separation standards on the safety and operational suitability of UAM operations. The fast-time simulation tool simulated the operations of electric Vertical Takeoff and Landing UAM aircraft, as well as the performance of tactical conflict management algorithms to maintain specified separation minima between UAM flights, while using several separation standards with various traffic scenarios developed for Dallas-Fort Worth International Airport UAM operations.

Patent Application Filed for Work Performed by SWS Team

POC: CHAD STEPHENS

On March 28, a provisional patent application was filed for the Risk Precursor Identification in Commercial Aviation Terminal Area Operations technology developed by the System-Wide Safety (SWS) team. The team developed a technology through exploratory work to anticipate and resolve potential safety issues, predict the health and robustness of aviation systems, and analyze integrated risks in terminal area operations and ground operations. A working prototype of the technology has been implemented in computer software with a user interface including data stream selection for applying various machine learning-based analyses and visualization of results of machine learning-based analyses. This new technology represents a novel analysis approach to traditional aviation operations safety data to be translated into In-time System-Wide Safety Assurance of autonomous systems. The coinventors are Fasil Alemante and Rami Houssami of Booz Allen Hamilton (BAH), Vincent Houston of NASA, Bryan Matthews of KBR, Dominic McConnachie of BAH, Peter Mehlitz of KBR, Nikunj Oza of NASA, Farley Reynolds of BAH, Jack Sarle (formerly BAH), Chad Stephens of NASA, and Shannon Walker of BAH. This new capability was presented at Aviation Safety InfoShare 2023.

UAM Hosts Transitional OIA Checkpoint Meeting

POC: JASON PRINCE

On March 28, the Air Traffic Management – Exploration project's Urban Air Mobility (UAM) subproject conducted a one-day initial checkpoint activity to assess use cases under consideration for the Transitional UAM Operational Integration Assessment (OIA). Participants included representatives from NASA, the Department of Transportation, FAA, National Air Traffic Controllers Association, and industry. The objectives of this checkpoint were to advance the baseline of the NASA/FAA Laboratory Integrated Test Environment capability, as well

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as demonstrate UAM operational scenarios for airport transfer mission use cases representing transportation of passengers between an urban environment and a nearby controlled airport utilizing electric Vertical Takeoff and Landing aircraft. The purpose of these exercises is to understand how UAM operations can scale to higher-tempo operations and more highly automated operations of the future.

SWS/AMIO Invited to Participate on Panel at German Embassy

POC: KYLE ELLIS

On March 29, representatives from the System-Wide Safety (SWS) project and the Advanced Air Mobility Mission Integration Office (AMIO) were invited to participate in the Modern Air Mobility event hosted by the German Embassy in Washington, DC. Kyle Ellis, deputy project manager of SWS, participated in an engaging science panel discussing technologies that will impact the future of aviation alongside a panelist from the German Aerospace Center, who is also collaborating with SWS through the International Forum of Aviation Research and an International Agreement. Nancy Mendonca of AMIO participated in a unification panel with the FAA, the European Union Aviation Safety Agency (EASA), and emerging market industry players. The event was

invitation only with several high-profile attendees including: Grant Farnsworth, Office of Science and Technology Policy (OSTP) within the Executive Office of the President; JoeBen Bevirt, founder and chief executive officer of Joby Aviation; Dirk Hoke, chief executive officer of Volocopter; Lirio Lio, executive director of airworthiness certification at the FAA; and Ludovic Aaron, EASA representative to the United States, amongst many others. The event was very well received and provided NASA an opportunity to engage with a wide variety of international participants working to identify and discuss the challenges and opportunities to evolve the global aviation industry to include Advanced Air Mobility missions.

SWS Participates in SAE Meetings This Quarter

POC: MALLORY GRAYDON AND PAUL MINER

This past quarter, representatives from the System-Wide Safety (SWS) project participated in multiple SAE meetings. On Jan. 30-Feb. 3, Mallory Graydon participated in the Quarter One Plenary Meeting of SAE's S-18, S-18A, and S-18H committees in Houston. S-18 has completed revisions to two well-known aviation safety standards: ARP4754A "Guidelines for Development of Civil Aircraft and Systems" and ARP4761 "Guidelines and Methods for Conducting the Safety Assessment

Process on Civil Airborne Systems and Equipment." Revised versions of these standards are likely to be released later this year. S-18, S-18A, and S-18H are also writing reports on: 1) the subject of "generic errors," including the meaning of the "no single failure" requirement for critical functions and whether this can be addressed by development assurance or diversity; 2) the use of the Systems Theoretic Process Analysis in a civil aviation context; 3) the applicability of ARP4754B and ARP4761A processes to Unmanned Aircraft Systems; 4) the interaction between human factors-related assurance activities and the safety assessment process; and 5) the use of tools and modeling in aircraft development. Graydon has been a major contributor to these efforts. The second meeting, held March 27-31, was hosted by MITRE in Virginia. Paul Miner, project scientist for SWS, participated in the plenary meeting for the SAE G-34/EUROCAE WG-114 Joint Committee for Artificial Intelligence in Aviation. SWS project researcher Alwyn Goodloe also participated in the meeting remotely. The purpose of the meeting was to discuss the latest draft document. At the meeting, there was meaningful progress towards resolving remaining technical content for the latest version of the draft document. The next plenary will be held June 27-30, 2023, in Cologne. The

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draft document will continue to be refined in ongoing virtual meetings.

ATM-X Conducts Visit and Discussions with Raytheon and Collins

POC: WILLIAM CHAN AND SHIVANJLI SHARMA

William Chan, project manager of Air Traffic Management – Exploration (ATM-X), and Shivanjli Sharma, deputy project manager of ATM-X, visited the Raytheon Technologies Aerospace Demonstration Enterprise Center in Washington, DC on March 31. The visit included a demonstration of their emerging airspace management tools and capabilities such as the Multi-Platform Application Re-hosting Solution system and digital tower capabilities, which are being developed to transform air traffic management of both conventional operations while also introducing adaptable features to support a host of new aviation entrants including: small-Unmanned Aircraft Systems, electric Vertical Takeoff and Landing vehicles, and remote cargo operation use cases. In addition to the demonstration, the NASA, Raytheon, and Collins teams discussed collaboration opportunities to further drive innovation in key surveillance systems needed for low altitude operations, as well as the need to develop and demonstrate command and control communication links for a variety of Advanced Air Mobility entrants.

William Chan (left) participating in meeting at Raytheon's facility

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AAM Participates in the Consumer Electronics Show

POC: STARR GINN

On Jan. 5-6, Starr Ginn, lead strategist for the Advanced Air Mobility (AAM) project, attended the Consumer Electronics Show in Las Vegas. The Consumer Electronics Show continues to expand their AAM content each year, as multi-modal solutions, electrification, and automation are big themes of the show. The following are a list of highlights from the event:

- ASKA showcased their prototype flying car aircraft for the first time. ASKA is a National Campaign International Information Exchange partner from the Announcements for Collaborative Partnership Opportunities-2. They will start envelope expansion this year.
- Palantir is a company helping Lilium with building software empowering organizations to effectively integrate their data, decisions, and operations. It used to take Lilium two weeks to evaluate data in between flights, which now they can fly each day.
- Supernal had very small footprint this year, unlike 2020. They were in the Microsoft booth after announcing their partnership to advance autonomy, digital operations, and cloud integration technologies.

- Archer announced their partnership with Stellantis, an electric vehicle company, to build electric aircraft with Archer and provide strategic funding for growth. There were many electric Vertical Takeoff and Landing (eVTOL) companies who participated on panels, including those that focused on regional air mobility, drone companies for emergency response, airspace companies, and supply chains for software and electronics.
- SkyDrive (of Japan) announced the SD-05, a two-passenger eVTOL aircraft operated by a driver pilot. SkyDrive is planning to use the SD-05 to launch air taxi service in the Osaka Bay area during the world exposition scheduled for 2025 in Japan.
- Plana (of South Korea) announced the creation of new and innovative short to medium-range clean and safe hybrid eVTOL passenger aircraft and its ecosystem.
- A Hall of Fame ceremony for Women in Emerging Aviation Technologies featured NASA's Huy Tran, director of aeronautics at NASA's Ames Research Center in California.
- The Aerospace Industries Association (AIA) hosted an Urban Air Mobility round table and evening event for industry to gather and network. David Silver, vice president for civil aviation at AIA, was the host.

- McKinsey & Company also hosted an AAM networking event that showcased a few simple Joby simulators.
- There was a Formula One autonomous race with seven domestic and international universities participating.

SWS Engages and Leads Scientific Community at AIAA SciTech 2023

POC: KYLE ELLIS

Several researchers from the System-Wide Safety (SWS) project provided presentations at this year's American Institute for Aeronautics and Astronautics (AIAA) SciTech Forum and Exposition, held in Maryland on Jan. 22-27. Each facet of the project from near-to-far-term operational and design safety was represented at the conference, including several topics on In-Time Aviation Safety Management Systems (IASMS), safety assurance, and model-based systems engineering. SWS researchers participated in numerous capacities: Terry Morris served as the chair of the information systems group; Samantha Infeld served as area chair for systems engineering and Complex Airspace Systems Exchange; and Natasha Neogi served as chair for the Intelligent Systems technical committee and as an organizer for the student paper

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Paul Krois, Crown Consulting, presented at the AIAA SciTech 2023 on IASMS for upper Class-E airspace operations.

competition. Neogi also participated as an inaugural member in the certification task force organized by AIAA. Daniel Weckler and Milad Memarzadeh gave a presentation on predictive and prognostic modeling research at the Data Sciences group session. Evan Dill cochaired the Digital Avionics technical session within which Kyle Ellis and Paul Krois presented on IASMS for upper Class-E airspace operations. Additionally, Kyle Ellis was invited to participate as panelist for the modeling and systems engineering technical committee session discussing autonomy and safety in future aviation systems. AIAA SciTech Forum 2023 was the largest on record, with more than 5,700 registrants from around the planet returning to in-person discussion and collaboration.

UAM Researchers Invited to Coauthor Portion of HCI Book
POC: RANIA GHATAS

Researchers from the Air Traffic Management – Exploration project's Urban Air Mobility (UAM) subproject, Rania Ghatas, Savita Verma, Richard Mogford, and Victoria Dulchinos, are coauthoring the Advanced/Urban Air Mobility (A/UAM) Human-Computer Interaction (HCI) section of a book chapter titled "HCI in Aviation" – part of a six-book series to be published by the CRC Press, LLC, Taylor & Francis Group. This chapter will be included in the sixth book titled "Human-Computer Interaction: HCI Application Domains" in the "Human-Computer Interaction: Foundations, Methods, Technologies and Applications" book series. This last book in the series focuses "on the relevant aspects and role of HCI in the design of interactive applications" across 16 broad domains including: aviation, education, games and entertainment, health and digital well-being, social computing, and more. The publication date of the book is anticipated for 2024.

DIP Researcher Jeremy Coupe Speaks at Google Fireside Chat
POC: JEREMY COUPE

On Feb. 21, Jeremy Coupe, project researcher in the Air Traffic Management – Exploration project's Digital Information Platform (DIP) subproject, was invited to speak to Google at one of their virtual Google Fireside Chats. Coupe described NASA's journey of implementing and evaluating a prototype decision support tool to aid in the management of traffic flows at the nation's busiest airports. There were 210 unique viewers attending the live chat. The Google organizer said it was a very informative presentation and a topic almost everyone could relate to.

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AOSP Leadership Highlighted as Part of NASA's imaginAviation Event
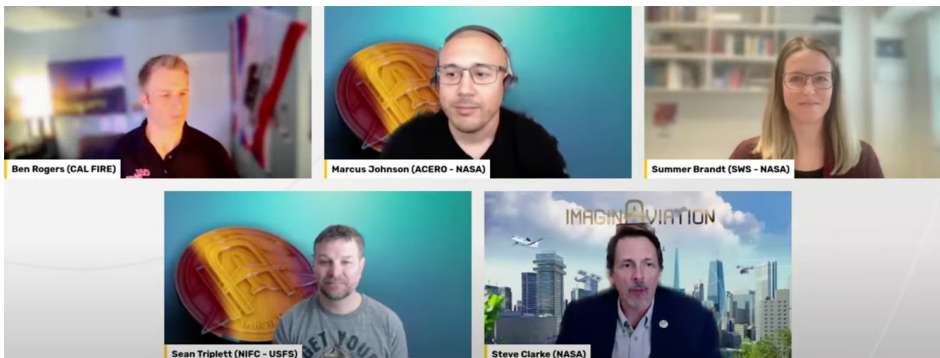
POC: MISTY DAVIES, SUMMER BRANDT AND MARCUS JOHNSON

On Feb. 28, AOSP project representatives participated as speakers in NASA's ImaginAviation conference. Misty Davies, project manager of System-Wide Safety project, and Shivanjli Sharma, deputy project manager of the Air Traffic Management – Exploration project, were panelists on the "Turning Data into Information" panel that addressed the challenge of strategically collecting and using data in a way allowing system operators to take informed actions. Kelley Hashemi, formerly from NASA's Transformational Tools and Technologies project, was also a panelist, while Supreet Kaur from the Data Reasoning Fabric project moderated the session. Later that day, Summer Brandt participated as a panelist on "Relief from Above - Aerial Innovation in Emergency Response." This panel highlighted NASA's efforts to benefit the public through enabling the use of aviation in emergency response situations to reduce risk and increase safety. Also on the panel was Marcus Johnson, project manager of the Advanced Capabilities for Emergency Response Operations project. Johnson discussed how the project is focused on improving airspace management for all parts of wildland fire response operations, including aerial suppression, and enhancing communications interoperability between Unmanned Aircraft Systems, piloted aircraft, and crews on the ground.

AOSP project representatives participate on panels at the imaginAviation event

Summer Brandt and Marcus Johnson also participate at the imaginAviation Event

ATM-X Participates in the Forward Fort Worth Conference

POC: SHIVANJLI SHARMA

On March 1, Shivanjli Sharma, deputy project manager of the Air Traffic Management – Exploration (ATM-X) project, participated on the "The Integration and Commercialization of Advanced Air Mobility Aircraft" panel at the Forward Fort Worth Conference

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held in Fort Worth. During the panel, industry leaders discussed the pathway to integration and commercialization for both Vertical Takeoff and Landing vehicles and small Unmanned Aircraft Systems and the challenges industry must overcome to strengthen the supply chain and deploy air taxis across densely populated areas, as well as their integration into the National Airspace System. Other panelists included Lesley Frana, vice president of strategic partnerships for DroneUp, and Bill Goodwin, deputy general counsel of policy and regulatory affairs for Joby Aviation. The moderator for the panel was Rob Lowe, regional administrator for the FAA's Southwest Region.

AFCM Automation Concept Presented
POC: TRISH GLAAB

On March 2, Vivek Sharma, deputy lead for the Advanced Air Mobility (AAM) project's Automated Flight and Contingency Management (AFCM) subproject, presented "Dynamic Path Planning (DPP) Automation Concept for AAM" as part of the ongoing Aviation Operations Seminar series. The series is part of the Intelligent Flight Systems product line sponsored by NASA's Langley Research Center in Virginia. The objective of the Aviation Operations Seminar series is to promote information sharing and technical exchange across the NASA

Aeronautics research community. DPP is the planning of a safe and operationally acceptable flight path to account for a dynamically changing operating environment in flight. The DPP concept informs other NASA technologies currently being tested and validated, such as Flight Path Management within the AFCM subproject. After providing a brief background, Sharma identified the primary components of the DPP concept with a system overview, notional architecture, and operational scenarios. The presentation was well received by a large group of in-person and virtual attendees.

SWS Research Nominated for Institute of Navigation Walter R. Fried Award
POC: EVAN DILL AND MISTY DAVIES

On March 10, a pending publication from System-Wide Safety (SWS) project researchers was nominated for the highly prestigious Walter R. Fried Award for best paper at the upcoming Institute of Navigation Positioning, Location, and Navigation Symposium. The paper, titled "Accuracy Assessment of Two GPS Fidelity Prediction Services in Urban Terrain," details a rigorous analysis on experimentally validating prognostic services to forecast the quality of Global Positioning System in urban areas. Data collection for this effort was completed in Corpus Christi, and

in collaboration with the Lonestar Unmanned Aircraft System test site. The award was established in 2000 for the recognition of individuals who made a substantial contribution to the technology of navigation and positioning equipment, systems, or practices. It also recognizes the best paper with regards to technical excellence in honor of the late Walter R. Fried.

SWS Participates at IEEE Conference
POC: LYNNE MARTIN

On March 4-11, System-Wide Safety (SWS) project researchers participated in the Institute of Electric and Electronic Engineers (IEEE) Aerospace Conference 2023 in Montana. The American Institute of Aeronautics and Astronautics and the Prognostics and Health Management Society acted as technical cosponsors for the event. The purpose of the conference was to promote interdisciplinary understanding of aerospace systems, their underlying science and technology, and their application to government and commercial endeavors. Papers presented at the conference focused on increasing knowledge of: 1) aerospace systems, science, and technology; 2) applications of aerospace systems and technology to military, civilian, or commercial endeavors; 3) systems engineering and management science in

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the aerospace industry; and 4) government policy that directs or drives aerospace programs, systems, and technologies. Representing SWS, Rajeev Ghimire presented a paper "Fault Detection and Diagnosis Techniques for Electric Unmanned Aerial Vehicle Powertrain System" which discussed fault detection and diagnosis techniques that can be helpful for detection and isolation of faults in powertrain systems.

SWS Participates at DRONERESPONDERS National Public Safety UAS Conference

POC: KYLE ELLIS

On March 14-15, several members of the System-Wide Safety (SWS) project team provided presentations at the DRONERESPONDERS National Public Safety Unmanned Aerial Systems (UAS) Conference held in Virginia. Kyle Ellis, deputy project manager of SWS, gave a presentation on the research and development plan for the Safety Demonstrator Series – a research effort focused on developing capabilities designed to improve the safety of expanded emergency response operations such as Beyond Visual Line of Sight and high-complexity airspace. The first responder and emergency response community has been an early adopter of UAS to assist in their operations. Given their local and regional authority, they are often granted emergency-use waivers to deploy UAS in their missions. However, the permitted use of UAS in these conditional waivers is still highly limited due to the inability to assure the safety for expanded use cases. The SWS project outlined its research plan, as well as an opportunity to partner with emergency and first responder communities, to tackle these safety challenges that are limiting UAS applications and to collect data to inform regulators to move towards a standards-based approach to rapidly approve UAS operations. SWS researchers also staffed a booth at the event and made important connections with key industry and government

SWS presented in the Safety Demonstrator Series and staffed a booth at the DRONERESPONDERS National Public Safety UAS Conference.

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entities interested in potential collaborative research opportunities.

AOSP Projects Participate at SAE AeroTech Conference

POC: SHIVANJLI SHARMA AND MICHAEL VINCENT

On March 15, representatives from the Air Traffic Management – Exploration (ATM-X) and System-Wide Safety (SWS) projects participated at the SAE AeroTech Conference in Fort Worth. Shivanjli Sharma, deputy project manager of ATM-X, provided a presentation on the Advanced Air Mobility (AAM) Research and Development Plenary Session. Sharma provided an overview of NASA's mission and indicated what research projects are contributing research and development to enable AAM. The session also highlighted the NASA activities supporting standards organizations

efforts and gaps research. Nancy Mendonca, acting mission manager for the AAM Mission Integration Office, moderated the panel. Michael Vincent, associate project manager for SWS, participated on another panel and introduced the concept of the In-Time Aviation Safety Management System to the audience and how it could help enable future airspace operations within the FAA's vision for an Info-Centric National Airspace System. Topics included NASA participation in standards committees, planned flight demonstrations, and recent research activities in vehicle, infrastructure, and human factors. The AeroTech Conference attracted approximately 400 people working on energy storage, vehicle subsystems, sustainability, and logistics problems in both automotive and aerospace.

Shivanjli Sharma (second from left) and Nancy Mendonca (standing) participating on the AAM Research and Development Panel at SAE AeroTech

SWS Researcher Presents at Air Charter Safety Foundation Safety Symposium

POC: JIM ACKERSON

Jim Ackerson, project researcher for the System-Wide Safety (SWS) project, was invited to speak at the Air Charter Safety Foundation Safety Symposium held March 20-22. The meeting was held at the Embry-Riddle Aeronautical University in Florida. His presentation, titled "The In-time Aviation Safety Management System Concept for Part 135 Passenger and Cargo Operators," included NASA's concept of an In-Time Aviation Safety Management System (IASMS) with a special emphasis on Part 135 operations including the progress of the FAA's current Safety Management System (SMS) and pending changes to its requirements. Unlike Part 121 operators, participation in the FAA's SMS program is voluntary for Part 135. The presentation addressed how increased participation from Part 135 operators can reduce accidents and how SMS can evolve to an IASMS. The Air Charter Safety Foundation is a non-profit organization with the mission to lead and support the advancement of the highest aviation safety standards. Membership is made up of the business, charter, and fractional ownership industry primarily operating under 14 CFR Parts 135 and 91.

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SOTERIA Study Team to Receive NASA Group Achievement Award

POC: CHAD STEPHENS

The System-Wide Safety (SWS) project's Human Contributions to

Safety (HC2S) SWS Operations and Technologies for Enabling Resilient In-Time Assurance (SOTERIA) study team will receive the NASA Group Achievement Award during the Spring 2023 NASA Langley Awards Ceremony. The SOTERIA flight simulation study is one example of how HC2S researchers are working together with Boeing, airlines, and aviation industry partners to better understand human contributions to safety in various facets of commercial aviation in order to enable aviation safety. The study will enable SWS researchers and aviation government/industry partners, such as the FAA, the National Transformation Safety Board, and airlines, to better understand human contributions

to safety in various facets of commercial aviation, as well as extend that knowledge to Advanced Air Mobility, to enable safe future operations in the National Airspace System.

ATM-X Supports Amsterdam Drone Week Panel

POC: SHIVANJLI SHARMA)

On March 22, Shivanjli Sharma, deputy project manager of the Air Traffic Management – Exploration

(ATM-x) project, participated as a panelist at the Innovative Air Mobility: Connecting Cities and Regions Conference in Amsterdam. The panel, titled "Integrating Air Mobility in an Urban Environment," focused on a variety of perspectives from city, state, federal, and international participants on the challenges and needs associated with integrating new aviation entrants into communities in a safe and effective manner. The dialogue included discussions on multi-modal integration, land use policy, and safe management of new aviation entrants – alongside the key technical and research challenges that still need to be addressed to enable scalable operations. Other panelists included: Jeroen Olthof, regional minister of Noord-Holland; Carlo van de Weijer, managing director of the Eindhoven Artificial Intelligence Systems Institute at Eindhoven University; Yolanka

Shivanjli Sharma (2nd from left), participates at the Innovative Air Mobility: Connecting Cities and Regions Conference

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Wulff, executive director of the Community Air Mobility Initiative; Andrew LeBovidge, executive vice president of the National Air Traffic Controllers Association; and city and state representatives from California.

SWS Researchers Present at Aviation Safety InfoShare Spring 2023

POC: NIKUNJ OZA

On March 28–30, several members of the System-Wide Safety (SWS) project team delivered presentations at the Spring Aviation Safety InfoShare in Baltimore. Fasil Alemante presented in the Dispatch track, on behalf of himself, while Chad Stephens and Nikunj Oza presented "Machine Learning Methods for Advancing Risk Precursor Identification Tools in Commercial Airline Terminal Area Operations" which included a demonstration of a tool to display flight risks. The SWS project plans to extend this tool to incorporate additional data and algorithms to allow for a more comprehensive depiction of flight risks at different time scales, thereby allowing users to focus their attention and expertise where they are needed most within a complex airspace. Mary Keller gave four talks on the Aviation Safety Reporting System (ASRS): "NASA ASRS Reports: Hazardous Materials in the Cabin" in the Cabin track, "NASA ASRS Reports about Rotorcraft Operations" in the Rotorcraft track, "Fender Benders: NASA ASRS Reports about Towing Mishaps" in the Maintenance track, and "NASA ASRS Reports about Business/General Aviation Operations" in the Business/General Aviation Operations track. At this workshop, the commercial aviation industry, government agencies, manufacturers, and others discussed aviation safety incidents, their causes, the methods through which the incidents were found, causes identified, and approaches to mitigate safety issues.