



# AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

JAN-MAR 2021 | Quarter 2



System-Wide Safety Receives 3  
Approval to Begin  
New Technical Challenge

Boeing Using SWS-Developed 10  
Tools and Processes to Explore  
Safety of Use Cases

## AOSP IN THE NEWS

### [NASA Sets Stage for Future Flights, Auditions of Advanced Air Mobility Technologies](#)

NASA's Ames Research Center in California (1/26) reports "the Air Traffic Management Exploration, or ATM-X, team is providing the virtual environment for third-party airspace service providers to rehearse their technology capabilities and ensure future Advanced Air Mobility vehicles or electric-powered vertical takeoff and landing vehicles can safely integrate with existing and future air traffic. The goal of the ATM-X project is to accelerate the development of software that is robust and integrated enough to increase automation..."

### [Elroy Air Teams with NASA to Test Autonomous Aerial Logistics](#)

Aviation Week (1/29) reports "autonomous cargo aircraft startup Elroy Air has joined NASA's Advanced Air Mobility National Campaign project and will exchange information leading up to flight tests in 2022. Elroy is developing the Chaparral hybrid-electric vertical-takeoff-and-landing (eVTOL) vehicle, which is designed to carry..."

### [Fit2Fly Aims to Make Future Drones Safe and Reliable](#)

NASA Aeronautics (2/02) reports "as more industries within and outside the aviation community become interested in using drones to provide services, the question of safety is paramount. These businesses must prove their aircraft won't fall out of the sky, so people feel comfortable with them carrying important cargo like packages, emergency supplies, and even people. The gulf we're trying to address is how we can get appropriate levels of safety and reliability from these new systems when they are so different from traditional aircraft, said Garry Qualls, co-lead researcher on Fit2Fly at NASA's Langley Research Center in Virginia. Qualls and his colleagues envision a system in which individual drones are able to detect any technical issues by themselves."

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

### System-Wide Safety Receives Approval to Begin New Technical Challenge

POC: [MISTY DAVIES](#)

On Jan. 14, the System Wide Safety (SWS) project received approval to begin a new Technical Challenge (TC) for the TC-5 Safety Demonstrator (SD) Series. The goal for the SD series is to develop and demonstrate an In-Time Aviation Safety Management System and deliver recommended requirements and evidence to regulators and industry standards committees. Misty Davies and Kyle Ellis gave a clear and concise presentation that was well received by the Directorate Program Management Council and the ARMD leadership team.

### ATD-2 Begins Dissemination of Daily TOS Activity Reports to Field Demonstration Partners

POC: [DIVYA BHADORIA](#)

On Jan. 14, the Airspace Technology Demonstration 2 (ATD-2) team launched the daily dissemination of Trajectory Option Set (TOS) activity reports for the FAA and field demo partner airlines, including American Airlines and Envoy Air at Dallas Fort Worth International Airport and Southwest Airlines at Dallas Love Field Airport. The content for the reports has been in development for several months, incorporating

feedback from field demonstration partners through biweekly meetings, tabletop exercises, and reviews of initial prototypes. The reports contain airline-specific details of the previous day's TOS activity for impacted flights based on data computed by the ATD-2 system on departure flights in Dallas's airspace. Additionally, the reports summarize cost-saving alternate routes suggested by ATD-2 to meet the demand-capacity imbalance in the D10 TRACON boundary arising from restrictions such as departure fix closures and Miles-in-Trail. The reports also provide estimated benefits at carrier, fleet, airport and system-wide levels associated with each TOS route. The field demo partners are eager to use the TOS Activity Reports to further their understanding of TOS benefits and continue to offer feedback to improve the ATD-2 system.

### SWS Participates in Flight Safety Foundation's Emergency Response Workshops

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

NASA's System-Wide Safety (SWS) project participated in the Flight Safety Foundation's series of workshops in January, which focused on responding to emergencies like wildfires and using unmanned aircraft systems (UAS). NASA and the Flight Safety Foundation are devel-

oping Disaster Monitoring for First Responder (DMFR) UAS scenarios as part of NASA's concept of operations for In-Time System-Wide Safety Assurance (ISSA). The Flight Safety Foundation hosted a series of three workshops intended to build risk frameworks, establish mitigations and services, and highlight gaps, benefits, and functions of ISSA for all DMFR scenarios. Workshop topics delivered were "Natural Disasters" on Jan. 20, "Wildfire Firefighting" on Jan. 22, and "Medical Delivery" on Jan. 25. According to Kyle Ellis, "the Flight Safety Foundation is contracted by us to engage the disaster/emergency response community across the globe to help build out our use cases for the Safety Demonstrator series and to establish community needs and buy-in from the industry at large." Charts created by Ellis for the ARMD Technical Seminar on the In-Time Aviation Safety Management System were featured during the workshops. NASA's attendees were active in the breakout sessions that discussed hazards, risk levels, ISSA's steps to monitor/assess/mitigate risk, and related services. Participants included Misty Davies, Kyle Ellis, Samantha Infeld, John Koelling, Parimal Kopardekar, Paul Krois, Robert Mah, Natasha Neogi, Lance Prinzel, and Laura Bass. Participating organizations in the workshops included NASA, the Flight Safety Foundation, Airbus, Amazon, Boeing, DJI, GlobalMedic, Hyundai,

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the International Association of Fire Chiefs, Médecins Sans Frontières, Porter County SAR, Rockwell Collins, Swiss FOCA, Transport Canada, UNICEF, the University of Michigan, Volansi, WeRobotics, and York County Fire in Virginia.

## NASA/FAA Quarterly Meeting on ATM-X

POC: [MIKE MADSON](#) AND [ROXANA CORZO](#)

Becky Hooey, program director of NASA's Aviation Safety Reporting Systems (ASRS), participated in the Unmanned Aircraft Safety Team (UAST) plenary meeting on Oct. 15. The UAST is a government/industry group chartered in 2016 to develop consensus-based and data-driven safety enhancements for unmanned aircraft systems (UAS) and operations. The team consists of more than 75 leaders representing organizations that span the UAS community from the FAA, NASA, and industry. Hooey described her team's work to enhance ASRS to enable better reporting of UAS incidents, including the development of a UAS-specific report form and augmentation of the existing ASRS taxonomy. The UAS-specific reporting capability is scheduled to launch in early 2021 and is expected to yield a rich data source that can be used by the FAA, NASA, industry, and academia to identify safety-relevant trends

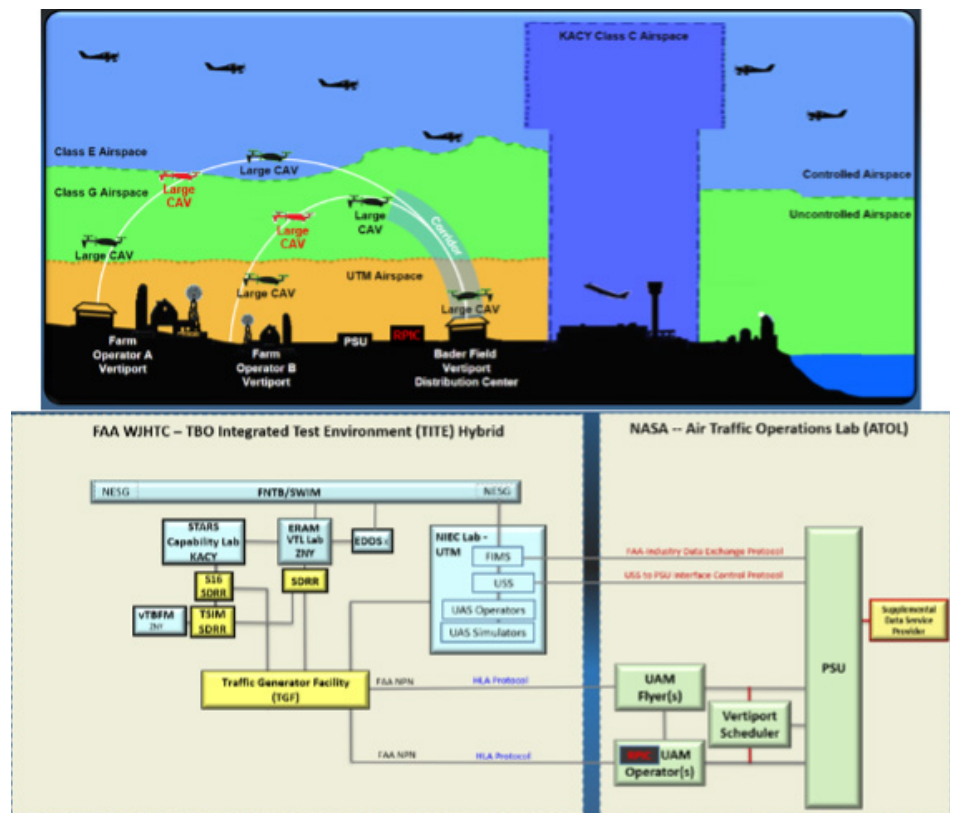
and incident precursors. This effort is extending an existing safety capability to include UAS and is represented jointly by Hooey and Steve Young, who is also a member of the UAST.

## NASA, Boeing, and FAATC Conduct Collaborative AAM Ecosystem Tabletop

POC: [IAN LEVITT](#)

On Jan. 29, the Air Traffic Management Exploration (ATM-X) project's Urban Air Mobility (UAM) sub-project participated in a virtual

meeting with the FAA William J. Hughes Technical Center (FAATC) Trajectory-Based Operations team, along with members of Boeing, as part of the Atlantic City Advanced Air Mobility (AAM) Use Case Exercise Two. The tabletop exercise supported detailed discussion on UAM cargo air vehicle operational use cases in the Atlantic City urban environment. It was organized by NASA, Boeing, and the FAA under an Inter-Agency Agreement Annex and a Collaborative Research and Development Agreement. A walkthrough of the phases of flight



Illustrations from AAM Ecosystem Tabletop

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for a range of operational use cases was conducted. The goal was to develop use cases of increasing complexity and tempo, identify risks and laboratory gaps, and leverage the results for performance and safety analysis of AAM. Atlantic City International Airport use cases will be used to drive laboratory integration between the FAATC and NASA, as well as the FAATC and related laboratory assets from Boeing to support future research, development, testing, and evaluation of emerging operational concepts and technologies. A follow-on activity will be scheduled to complete the activity. An artifact will be developed to capture Use Case Exercise Two discussions and outcomes.

### ATM-X UAM Sub-Project Delivers Software Releases

POC: [SPENCER MONHEIM](#)

On Jan. 29, the Air Traffic Management Exploration (ATM-X) Urban Air Mobility (UAM) sub-project delivered the first software release to the Advanced Air Mobility High Density Vertiplane (HDV) sub-project as part of a collaborative effort between the them. The software deliverable, was comprised of airspace system components developed for, and operationally tested in, the UAM X-3 Airspace Simulation sub-project and the National Campaign Dry Run Build-2 flight test. UAM will

continue delivering software releases to HDV after major milestones such as the X-4 simulation.

### SWS Presents at Strategy Planning Meeting between NASA Aeronautics and the FAATC

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

On Feb. 2, the System-Wide Safety (SWS) project participated in a strategic planning meeting with the William J. Hughes FAA Technical Center (FAATC) hosted by center director Shelly Yak. In support of this activity, SWS presented the In-Time Aviation Safety Management System (IASMS) concept and Machine Learning/Artificial Intelligence (ML/AI) certification research efforts. Several topics were discussed, and the primary focus was sharing research being conducted in the Airspace Operations and Safety Program (AOSP), Advanced Air Vehicles Program, and work being done at the FAATC. In addition, there were discussions on the facilities and resources the FAA has available. NASA presentations described the focus on building towards the FAA's 2035 vision, what the 2045 vision of the National Airspace System may be, and work being conducted to that end. Information exchanged between NASA and the FAA outlined collaboration opportunities and the means to develop digital information exchanges that enable

coordinated research across research and development stakeholders. This information is relevant to SWS's IASMS, ATM-X's Digital Information Platform, Digital Mesh Technology and Applications, and data fabric research efforts by others in NASA Aeronautics. The meeting was organized with the following topics: (1) Current and Potential Collaborations Overview; (2) Vehicle Technologies; (3) Big Data Analytics (ML/AI and Integrated data); and (4) Safety and Certification Technologies. SWS presented IASMS and ML/AI assurance methods, and AOSP director Akbar Sultan discussed cybersecurity. There was general consensus that several areas for potential collaboration exist, and NASA Aeronautics program directors and Shelly Yak of the FAATC will continue discussions on them.

### SWS Researchers Released a New Turbofan Engine Degradation Simulation Data Set

POC: [CHETAN KULKARNI](#)

On Feb. 2, System-Wide Safety (SWS) researcher Chetan Kulkarni of the Diagnostics and Prognostics Group and the Prognostics Center of Excellence, along with external partners Olga Fink of ETH Zurich, Kai Goebel of PARC, and Manuel Arias Chao released a new Turbofan Engine Degradation Simulation data set. The data set

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was generated with the Commercial Modular Aero-Propulsion System Simulation (C-MAPSS) dynamic model. A previous engine degradation data set has 65,000+ downloads and more than 30 publications comparing different fault diagnostics and prognostics algorithms. The generation of data-driven prognostics models requires significant run-to-failure data. The newly released dataset provides synthetic run-to-failure degradation trajectories of a small fleet comprising of nine turbofan engines with unknown and different initial health conditions. Real flight conditions as recorded onboard a commercial jet were taken as input to the C-MAPSS model. The diversity of perspectives from the inter-organization team supported the creation of a robust and complete data set incorporating a diverse set of failure modes relevant to the broader prognostics and health management community. The damage propagation modelling used for the generation of this synthetic data set builds on the modeling strategy from previous work done within the group.


The released data set is available as data set #17 at: <https://ti.arc.nasa.gov/tech/dash/groups/pcoe/prognostic-data-repository/>

### NASA Deploys New Capabilities for ATD-2 Phase 3 Field Demonstration


POC: [ERIC CHEVALLEY](#)

On Feb. 3, the Airspace Technology Demonstration 2 (ATD-2) team deployed a new version of the Phase 3 Integrated Arrival Departure Surface (IADS) system. ATD-2 Phase 3 is focused on developing and demonstrating technology for collaborative rerouting of departing flights to reduce delays and improve operational efficiency. The collaborative rerouting is enabled by the digital exchange of candidate Trajectory Option Sets between airline flight operators

and air traffic controllers. Seven different airline and air traffic control facilities in the North Texas region are participating in the ATD-2 Phase 3 field demonstration. This latest IADS software version (v5.11.3) introduces new features and data intended to promote greater system use and provide more operational benefits when the Phase 3 system is formally evaluated during the stormy season of 2021, beginning in April. Two key enhancements have been implemented, including new data elements, providing estimates of a flight's arrival delay at the destination airport for both the filed route and alternate routing options. The predicted arrival delay will help



### New IN Delay Data Elements



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<b>Flight's Filed Route IN Delay</b>	<b>+30 min</b>
Flight's predicted arrival delay at the destination's parking gate based on the airline's IN-block schedule data	
<b>+ TOS Route IN Delay Savings</b>	<b>-20 min</b>
Flight's TOS route delay savings accounting for:	
<ul style="list-style-type: none"> <li>• Delay savings at OFF, and</li> <li>• Flight time difference on the TOS route</li> </ul>	
<b>= TOS Route IN Delay</b>	<b>+10 min</b>
Flight's predicted delay at the destination's parking gate for the flight on this alternative route	

In this example, the flight is predicted to arrive **+10 min** late at the destination on the TOS route instead of **+30 min** late on the current filed route.

*Example of the new "IN" (aircraft gate arrival time) delay information*

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participating airlines better assess how much delay they may be able to recover at the destination airport by flying alternative TOS routes (see illustration below). The new data indicates potential delay savings with regards to both system delay and the airline schedule, thus providing additional support to airline's tactical operational decisions. This is the first time that the ATD-2 system provides gate-to-gate predictions for a set of routes to field demonstration partners. New logic was added to enable a more agile reroute approval process by air traffic control personnel, reducing user workload as well as ensuring more accurate data collection. This third release in the IADS 5.11 series included 65 modifications. All three of the 5.11 software releases (with over 200 modifications) are enhancements based on lessons learned from operational and shadow testing, and feedback from users since summer 2020. The maturation of the software has been made possible through close engagement between the ATD-2 team and field demonstration partners. Recent months have shown a significant increase in TOS reroute submissions by airlines and TOS reroute approvals by air traffic control. Field demonstration partners have come up with innovative ways to use the tools and make decisions that benefit both airlines and air traffic control operations. The ATD-2 team continues to actively monitor field

activities, engage with users, and analyze data that has been collected.

### **ATD-2 Briefs Stakeholder Community**

POC: [JEREMY COUPE](#) AND [MIRNA JOHNSON](#)

The Airspace Technology Demonstration 2 (ATD-2) team conducted several briefings to their FAA stakeholders this past quarter. The first meeting was held on Jan. 15. The ATD-2 team briefed the FAA's Flow Evaluation Team (FET) and Surface Collaborative Decision Making Team (SCT), and provided updates on the ATD-2 Phase 3 Field Evaluation in the North Texas metroplex. Highlights of the Phase 3 Field Evaluation include new emerging use cases that leverage the Trajectory Option Set and analysis of predicted benefits associated with an event that occurred on Dec. 30, 2020, driven by heavy terminal restrictions in response to an adverse weather scenario. During a four-hour period on Dec. 30, the east departure gate was restricted to a single departure fix and the flow was subject to an additional ten miles-in-trail, passing back significant delay to the surfaces of both Dallas Fort Worth International Airport and Dallas Love Field. While the east departure gate was restricted, the north departure gate was unrestricted, and flights travelling northeast could reroute through the north gate with little delay while incurring only a

slight increase to the overall flight time. During this event, the ATD-2 Phase 3 system recommended 53 flights for Trajectory Option Set reroutes with an average predicted delay savings of 38.7 minutes to the individual rerouted flight, and an average predicted system-level Metroplex savings of 85.8 minutes. ATD-2 also updated the FET and SCT teams on the Machine Learning (ML) Airport Surface Model that is under development in a parallel effort to the Phase 3 Field Evaluation. The ML Airport Surface Model was designed to be a scalable replacement for the capabilities provided by NASA's Surface Trajectory Based Operations (STBO) subsystem which is a component of the fielded Phase 3 system. The STBO system relies heavily upon detailed adaptation that defines the physical constraints and subject matter expert knowledge encoded in decision trees and creates a costly bottleneck to scaling the Phase 3 system across the National Aircraft System. ATD-2 is working to complete the initial build of the adaptation-free ML Airport Surface Model before the Stormy 2021 season to allow for a shadow evaluation against the traditional STBO system. In addition, the Air Traffic Management Exploration project's Digital Information Platform (DIP) sub-project provided a briefing on the DIP concept to facilitate the continued collaboration between NASA and the FAA. DIP was

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represented by Mirna Johnson, DIP sub-project manager, and is leading up the project formulation. Johnson introduced the FET and SCT to the high-level goals and scope of the DIP sub-project and began a conversation focused on how DIP can maintain the momentum fostered by ATD-2.

On Feb. 18, a second meeting was held with the Systems Wide Information Management (SWIM) Industry-FAA Team (SWIFT) community's thirteenth meeting. SWIFT was established by the FAA in response to requests from industry and provides a venue where participants can engage and learn about National Airspace System SWIM data and information services along with other SWIM services to improve system integration, automation, system interoperability, and communication networks. Again, the ATD-2 and DIP teams conducted presentations to the SWIFT team, which were well received by the SWIFT community. The audience of more than 200 attendees was highly engaged and actively asked questions about both the ML Airport Surface Model and about future opportunities to collaborate with DIP. NASA looks forward to continued collaboration with the SWIFT community.

### **SWS Engages with Industry Through AAM Crosscutting Working Group**

POC: [KYLE ELLIS](#)

On Feb. 18, the NASA Aeronautics Research Institute hosted the In-Time

System-Wide Safety Assurance/In-Time Aviation Safety Management System Concept of Operations (ConOps) follow-up discussion for the NASA Advanced Air Mobility Crosscutting Working Group. The Crosscutting Working Group focuses on providing guidance, standards, and requirements for key elements that pertain to safety, security, autonomy, affordability, the National Campaign, and the Urban Air Mobility Community Concept of Operations. The meeting included panelists Peter Sachs of the FAA, Eric Watson of Zipline, Andrew Carter of Resilience, Ella Atkins of the University of Michigan, and Peter Shannon of Radius Capital. The audience interactively participated with the panelists. In addition, Kyle Ellis from the System-Wide Safety project described the In-Time Aviation Safety Management System vision for a safe National Airspace System, emphasizing the importance of data. To view the recording and learn more, visit <https://nari.arc.nasa.gov/aam-portal/crosscutting>.

### **UAS Traffic Management Technical Interchange Meeting**

POC: [JAEWOO JUNG](#)

On Feb. 23, NASA hosted a one-day Unmanned Aircraft Systems (UAS) Traffic Management Technical Interchange Meeting (UTM TIM) to share insights on the research conducted and the lessons-learned in UTM. For this virtual event, approximately 900

participants around the globe registered in advance, and during the livestream, there were more than 1650 playbacks. Playbacks refer to the number of times a viewer starts watching the YouTube live video. During the peak viewing time of 7:30–8:30am Pacific time, 375 concurrent viewers watched presentations on the UTM project overview, history, and concept and use cases. The meeting featured 16 different speakers, including NASA and FAA leadership, with 11 in-depth technical presentations. In addition, a panel of experts internal and external to NASA discussed the global impact of UTM. Materials from the meeting are available at <https://nari.arc.nasa.gov/utm2021tim>

### **NASA and FAATC Complete Initial Network Testing**

POC: [RONALD MADDOX](#)

On Feb. 24, the Air Traffic Operations Laboratory (ATOL) at NASA's Langley Research Center in Virginia completed low-level network interconnection testing with the FAA William J. Hughes Technical Center to enable joint testing and Advanced Air Mobility (AAM) research. This work is being conducted through a NASA/FAA inter-agency agreement and is funded by the Air Traffic Management Exploration Urban Air Mobility sub-project. In the coming weeks, additional testing will demonstrate the sharing of



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simulation state data between systems used to evaluate NASA's AAM concepts in the ATOL with the FAA's air traffic control and flight simulator laboratories at the FAATC. Connectivity with FAA baseline systems facilitates NASA's development of AAM simulators and tools while also enabling the FAA to expand the Trajectory Based Options Integrated Test Environment, advancing its test readiness capabilities. This integration positions both NASA and the FAA to lead research related to emerging and future airspace concepts and technologies.

### Joint Management Plan Established Between ATM-X/ UAM and AAM/National Campaign

POC: [KEVIN WITZBERGER](#) AND [SHIVANJLI SHARMA](#)

On Feb. 24, a key baseline management document to formalize the collaboration between teams within NASA Aeronautics was established in support of the Advanced Air Mobility (AAM) National Campaign (NC). The Joint Management Plan (JMP) details the unique collaboration needed to ensure an integrated vehicle and airspace operational environment for the NC series, involving extensive efforts by two projects within two programs: the Integrated Aviation Systems Program's AAM NC sub-project and the Airspace Operations and Safety Program's Air Traffic Management Exploration Urban

Air Mobility (UAM) sub-project. The JMP defines processes and establishes a joint approach for managing requirements, risks, schedule, and reviews. Specifically, the JMP will guide technical teams across programs in sharing requirements while also facilitating bidirectional software deliveries needed for the simulation and flight test infrastructure environments. This collaboration will enable testing of future operational constructs with the delivery of UAM airspace components for flight testing, as well as consistent data collection frameworks for simulation and flight activities. Through this collaboration, the sub-projects will work together to benefit their respective objectives in support of NASA Aeronautics' vision to make possible a safe, economically sustainable AAM transportation system.

### SWS Year Two Meeting of NASA Research Agreement Topic 1

POC: [NATASHA NEOGI](#) AND [PAUL MINER](#)

On Mar. 2-3, the System-Wide Safety project conducted the Year Two meeting of NASA Research Agreement Topic 1: "Assuring Increasing Autonomous Systems with Non-Traditional Human-Machine Roles." Presentations were made by two awarded grantees. On Mar. 2, the first team, led by Principal Investigator (PI) Amy Pritchett of Pennsylvania State University, presented on the topic of

"Assuring Increasingly Autonomous Capabilities with Novel Delegations of Authority and Responsibility." Co-PI Cody Fleming of Iowa State University presented work related to an extended safety methodology. The presentations included a summary of past accomplishments from Year One, modeling and simulation results in the work models that compute formalism, and theory and examples in the Safety Modelling and Analysis framework. The second team was led by PI Jennifer Davis of Collins Aerospace, who presented work related to the "Assured Human Machine Interaction for Increasingly Autonomous Systems (AHMIAS)." Subcontractors of Team 2 are co-PI Siddhartha Bhattacharyya of the Florida Institute of Technology and Co-PI Randolph Jones of Soar Technologies. On Mar. 3, the Collins Aerospace team presented a safety assessment approach (a project status including accomplishments, findings, work in progress), a scoped Concept of Operations and relevant examples, and a framework and techniques for conducting safety assessments.

### SWS Invited to Present on Assurance of Autonomy to NITRD's SPSQ Working Group

POC: [MISTY DAVIES](#)

On Mar. 4, Misty Davies of the System-Wide Safety (SWS) project gave an invited presentation on SWS's Assurance of Autonomy effort to the Networking and Information Technology Research

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and Development (NITRD) Software Productivity, Sustainability and Quality (SPSQ) Interagency Working Group. The presentation gave an overview of the overall goals and timeline for the NASA technical challenge and highlighted recent successes and the related publications for the effort. SPSQ members were very interested in the advancements to the state of the art and details of the collaboration between SWS and DARPA's Assured Autonomy effort.

### **Kickoff Meeting for In-Time Learning-Based Safety Management for AAM/UAM Operations**

POC: [STEVE YOUNG](#)

On Mar. 8, kickoff meeting was held to summarize and review plans for a new cooperative research agreement with a team from George Washington University, MIT-Lincoln Labs, Vanderbilt, and the University of Texas. This agreement results from a NASA Research Announcement solicitation, and all planned work complements ongoing research in the System-Wide Safety (SWS) project. During the meeting, it was discussed how to best collaborate over the term of the effort. The three-year research activity will encompass the design, development, and demonstration of an in-time learning-based aviation safety management system (ILASMS) for

scalable heterogeneous advanced Urban Air Mobility operations. The proposed innovations include: (1) an integrated safety management system architecture spanning onboard systems, ground control stations, and cloud-based services; (2) data-driven learning-based detection, assessment and prediction of anomalies, trends, and mission risks; (3) verifiable automated operational mitigation for resilience and scalability; and (4) closed-loop interfaces between detection/prediction and mitigation with safety guarantees for mitigation in the presence of imperfections and possible detection errors that may be introduced by learning-based approaches. System validation and demonstrations will use relevant scenarios during both simulations and sub-scale flight tests.

### **Boeing Using SWS-Developed Tools and Processes to Explore Safety of Use Cases**

POC: [MISTY DAVIES](#)

On Mar. 11, Boeing highlighted a collaboration with NASA to FAA technical experts in which the company is using System-Wide Safety project-developed tools and processes to explore the safety of Boeing-developed autonomy use cases. Boeing presented current results to FAA attendees and showed how NASA-developed tools could automatically find defects

and increase the confidence in the behavior of highly automated systems. FAA technical experts included George Romanski, FAA Chief Scientific Advisor for Aircraft Computer Software; Rick May, FAA expert on aircraft certification; Robert Jones, Lead for the Flight Control Technical Community Research Group; and Mike Vukas of the FAA Policy and Innovation Division.

### **ATM-X-CTM/ETM Team Continue Meetings with Stakeholders**

POC: [JAEWOO JUNG](#)

The Air Traffic Management Exploration project's Collaborative Traffic Management/Upper E Airspace Traffic Management (CTM/ETM) team held several stakeholder meetings this past quarter. The first meeting was held on Feb. 3 with the FAA's NextGen ETM team and was a dedicated meeting with Boom – one of the leading companies in the supersonic transport arena. Joining the discussion from Boom was a certification and airworthiness expert and a company pilot with background as a US Air Force test pilot. The intent of the meeting was to gain a better understanding of Boom's operational plans and vehicle characteristics as part of the ETM team's efforts in developing its concept and preparing for modeling and simulation work aimed at integrating supersonic operations into a cooperative ETM environment.

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The discussion covered various aspects of intended operations, operating characteristics, and considerations for planning and airspace management. The meeting was also an opportunity for the Boom team to share their research and simulation needs and ask the NASA and FAA teams for more details on planned work in ETM and its potential impacts and outcomes. Follow up meetings are planned with Boom and additional feedback is expected to help inform NASA and FAA teams' ETM engineering and research efforts.

The next meeting was held Mar. 12 and again included representatives from the FAA and industry. This meeting was the first in a series of meetings to discuss and further develop ETM concepts. More than 60 industry representatives participated, including those from commercial supersonic transport (Boom and Aerion), fixed-wing HALE (Swift, AeroVironment, Airbus, Aurora), airships and balloons (SCEYE, Loon, Aloft Research), and government partners such as the Department of Defense. During this meeting, topics covered included community activities such as planned stratospheric test flights of SCEYE's airship platform and the US Army Zephyr program; industry responses to NASA and the FAA's ETM information request; the introduction of a lexicon to capture the ETM community's proposed Upper Class E "rules of the

road;" and Cooperative Operating Practices. The needs and constraints for supersonic flights, including the potential impact of shockwaves from supersonic operations on balloons and high aspect-ratio aircraft (e.g., solar-powered flying wings), were also introduced for further investigation and discussion. NASA and the FAA's modeling and simulation progress were also presented. The next ETM meeting is tentatively scheduled for May 2021.

### SWS Researchers Continue Collaboration Efforts with American Airlines

POC: [MISTY DAVIES](#), [LANCE PRINZEL](#)  
AND [JOHN KOELLING](#)

System-Wide Safety (SWS) and American Airlines have been working together to address identified needs arising from COVID-19. Five NASA/American Airlines teams were formed to collaboratively address these needs.

One of these teams has been working with the airline to examine safety events in preflight and pushback phases. On Jan. 11, American Airlines invited SWS researchers to contribute an article to the company's pilot magazine, Safety Preflight. Steve Casner, Chad Stephens, and Kaitlyn Fox (SWS Communications Lead) co-authored the article with contributions from Lance Prinzel and Daniel Kiggins (SWS airline pilot subject-matter expert). As part of a larger multi-part mitigation strategy, the article helps bring increased awareness of the problem to pilots. The article is scheduled to appear in the February 2021 edition of the magazine. As a follow-on activity, the team collaborated with the joint American Airlines/Allied Pilot Association Flight Aviation Safety Action Program team to address safety issues in a series of articles for Safety Preflight. Three articles were recently published in the January/



(L-R) American Airlines pilots watching the SWS-created required training video that Dan Kiggins, American Airlines pilot and NASA SME, and Steve Casner, NASA Senior Research Psychologist, helped to develop.

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February issue and the March issue. The articles showcase the beneficial collaboration between NASA and American Airlines, especially with regards to flight safety. The articles are titled “The Impact of Covid-19 on American Airlines Operations: A New Perspective on Some Old Problems,” “Improving Aviation Together: NASA and American Airlines Collaboration,” and “Is the Last Inflight Rest Break Really the Best?”

On Mar. 17, American Airlines’ Director of Training reached out to the SWS team to help address an identified issue that their pilots were experiencing. As part of the collaboration, the teams worked together to produce a six-minute human factors video that will be shown to more than 13,000 pilots during recurrency training. The training video focuses on the effects of distraction on safety, and how NASA and American Airlines are collaborating to mitigate distraction on the flight deck. Chad Stephens, NASA Research Scientist; Lance Prinzel, SWS Senior Technical Advisor; and Kaitlyn Fox coordinated with Steve Casner and Daniel Kiggins to develop a script and shoot the footage remotely. This project was a collaborative effort involving the Media Solutions Branch and Public Affairs at NASA’s Langley Research Center in Virginia and Public Affairs at NASA Headquarters in Washington. The feedback from American Airlines regarding the

production has been overwhelmingly positive. After showing the film, the airline’s Director of Training gave feedback that the video is “the most popular part of the training class.”

### **National Campaign Initiates Dry Run Build #2 UAM Surrogate Flights**

POC: [SHIVANJLI SHARMA](#) AND [KEVIN WITZBERGER](#)

The Advanced Air Mobility project’s National Campaign (NC) sub-project initiated Dry Run Build #2 flight activities on Mar. 6, marking the start of a two-week flight test window during which the NC Flight Test Infrastructure was tested along with exercising the data collection system, scenarios, and test techniques needed for future flights. The Build #2 flight tests were conducted in cooperation with representatives from the FAA and utilized a Flight Research Inc. OH-58C helicopter acting as a representative Urban Air Mobility (UAM) vehicle at NASA’s Armstrong Flight Research Center in California. The Build #2 flight test was focused on capturing foundational vehicle and operational data (including test points around flight maneuvers and vehicle characteristics expected by UAM vehicles), UAM approaches and departures from heliport and vertiport infrastructures, and flights designed to simulate future UAM missions – as well as preflight planning, ground operations, flight operations, and contingencies. The NC Flight Test Infrastructure

includes real-time Automatic Dependent Surveillance-Broadcast (ADS-B) inputs to inform an airspace component provided by the UAM sub-project to represent a future, third-party airspace provider. Data collection systems included a differential GPS, instrumentation onboard the vehicle, and instrumentation provided by the FAA Flight Inspection Airborne Processor Application. The Build #2 UAM Surrogate Flights provided baseline data needed to support evolutions in vehicle, infrastructure, and airspace requirements that will enable the advent of UAM in the National Airspace System. In addition, a virtual VIP Day was held on Mar. 19 that showcased an early version of airspace tools that the UAM sub-project is developing to derive airspace requirements. Spencer Monheim of NASA’s Ames Research Center in California presented an overview of the airspace system used and how it fits into the research plans that will ultimately result in requirements for future UAM operations.

### **ATM-X and UTM Projects Meet with FAA to Discuss Future RTT Plans**

POC: [JAEWOO JUNG](#)

NASA and FAA Unmanned Aircraft Systems Traffic Management (UTM) Research Transition Team (RTT) representatives met to discuss handing off the UTM RTT work from the UTM project to the Air

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

Traffic Management Exploration project on Mar. 22. The meeting set the stage for future discussions that will be used to scope continued collaboration activities. UTM pioneered the service-based architecture complementing the FAA's air traffic management system for enabling new entrants operations. Future discussion will help ensure NASA's awareness of the FAA's UTM implementation plans and further use of the UTM-inspired eXtensible Traffic Management for enabling new airspace applications such as Urban Air Mobility and Upper Class E operations.

### DIP Request for Information Now Open for Stakeholder Participation

POC: [MIRNA JOHNSON](#)

On Mar. 23, the Air Traffic Management Exploration project opened the NASA Digital Information Platform (DIP) for stakeholder participation through the release of a Request for Information (RFI) and a website enabling stakeholders to learn more about DIP information sessions and collaborative opportunities. The objective of the RFI is to learn more about stakeholder needs and receive concept feedback of DIP. The RFI also expresses the project's approach to engaging stakeholders in future demonstrations. DIP is interested in potential partnerships to help guide the development of the concept

as well as potential partnerships for collaborative demonstrations with NASA. The DIP sub-project is focused on designing, developing, and demonstrating a digital data ecosystem to accelerate transformation of the National Airspace System through cohesive decision making. The cloud-based platform will allow easy access to aviation-related data based on stakeholder-informed requirements.

Stakeholders are encouraged to register on the newly available website to learn more about DIP. There is also an option for the community to submit a response to the RFI to enable NASA to better define a collaboration strategy and identify community needs and goals. Link: <https://nari.arc.nasa.gov/atmx-dip>

### DARPA ARCOS Principal Investigator Meeting

POC: [PAUL MINER](#), [MALLORY GRAYDON](#)  
AND [NATASHA NEOGI](#)

On Mar. 23, Mallory Graydon, Natasha Neogi, and Paul Miner participated in the virtual principal investigator meeting for DARPA's Automated Rapid Certification of Software (ARCOS) Program. The purpose was to kick off the second assessment phase for Technical Area 1, "Evidence Generation." The meeting consisted of updates from GrammaTech, Lockheed Martin, SRI, GE, and Boeing on their work to date and expectations for the next

assessment phase. Graydon, Neogi, and Miner are part of the government subject matter expert review panel supporting DARPA's evaluation of the ARCOS Program results.

### PAAV Market Study Final Briefing and System Model Training

POC: [ROBERT FONG](#)

The Pathfinding for Airspace with Autonomous Vehicles (PAAV) sub-project within the Air Traffic Management Exploration (ATM-X) project held their final market study briefing from the Logistics Management Institute (LMI) on Mar. 3. With more than 30 interviews, this briefing engaged with NASA, the FAA, industry participants, and stakeholders. The purpose of the study was to help the ATM-X project develop an understanding of the markets, risks, and opportunities for developing increasingly automated air cargo vehicles in the National Airspace System.

The PAAV sub-project will continue to coordinate with LMI to incorporate the feedback received during the briefing in order to draft a final report by April 2021. As a follow-on activity, on Mar. 24, the PAAV team initiated a market study through LMI to provide information on the forecasted market, risks, and opportunities associated with the integration of unmanned cargo vehicles in the National Airspace

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

System. To support this study, a systems dynamics model was developed to explore the effects of various input parameters on this emerging operational segment. This model uses market drivers, innovative business and operational models, and technology game changers such as autonomy and using conservative, expected, and aggressive assumptions for near-term (2025–2030) and mid-term (2030–2035) operations. The model captures the behavior and impacts of key stakeholders such as the air cargo industry, aircraft manufacturers, NASA, FAA, shippers, the public, and elements of the national transportation system infrastructure. The PAAV team completed training on this model to understand adjustments to parameters that can be made in the model to reflect emerging responses and permit PAAV to fine tune the forecasted market for adoption of unmanned cargo vehicle operations and guide investment strategies.

### NASA and DLR Explore Collaboration Efforts

POC: [HANBONG LEE](#) AND [TAUMI DANIELS](#)

In September 2020, NASA began a collaborative effort with the German Aerospace Center (DLR) under the Air Traffic Management Exploration (ATM-X) project to explore topics related to the development of a future airspace system that enables a diverse set of operations, including thin-haul aircraft,

various Unmanned Aircraft Systems, Urban Air Mobility (UAM), and supersonic transport in a scalable, flexible, and resilient manner – ensuring safety and security for both existing and new users. As part of this collaborative effort, a joint team for the UAM network task under the UAM foundational research work package is responsible for developing the necessary knowledge to identify the advantages and disadvantages of different UAM network designs, network scheduling algorithms, and UAM demand prediction models. Since the kickoff meeting in September, the UAM network task team has discussed the concepts of the network design and management and exchanged related information during monthly meetings. At the most recent meeting in February 2021, NASA and DLR chose Dallas and Hamburg, respectively, as the target metropolitan areas for collaborative study. This collaboration will continue to engage in technical discussions on which topics for the coming year include common assumptions, requirements, congestion control approaches, and performance metrics. Reference scenarios for these selected cities will be developed and used in simulations to evaluate the performance of different network designs under various conditions. As a related activity, ATM-X researchers participated in a semi-annual review with DLR on Mar. 25. Ian Levitt

presented an overview of UAM research. John Foster, Hanbong Lee, Hok Ng, Kee Palopo, and Jerry Smith presented results from their research along with their respective DLR partners. This collaboration with DLR is a five-year effort with seven tasks or work packages defined and staffed by NASA and DLR researchers. Each of the teams is working towards annual milestones for their respective tasks. These tasks include UAM demand analysis, network analysis, impacts analysis, flight performance, and testbed and Remote Component Environment (RCE) integration. RCE is the DLR equivalent of Testbed. Other tasks that are scheduled for a future review include digital trajectory negotiation and integrated flow management.

### ATM-X Continues DIP Briefings to Stakeholders

POC: [MIRNA JOHNSON](#)

The Air Traffic Management Exploration (ATM-X) project's Digital Information Platform (DIP) sub-project conducted numerous briefings to stakeholders this past quarter. On Feb. 8, the team presented to Airlines for America's Air Traffic Management Council. The presentation introduced the vision and objectives to Airlines for America. The ATM-X team shared the motivation for the project and how previous research from Airspace Technology Demonstra-

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tion 2 provided formulation input towards an architecture that allows high re-use of solutions. An invitation was extended to continue collaboration between airlines and NASA to inform operational needs and prioritize benefits to demonstrate. Collaborative demonstrations are planned throughout the DIP project cycle and operator validation will be valuable to guide partners in the airspace services to be developed on DIP. A follow-on session was held for the FAA's NextGen Integration Working Group Committee on Feb. 25, and then with Delta Airlines on Mar. 25. The plan is to continue socializing DIP up to airlines and the FAA's NextGen Advisory Committee, as NASA is interested in obtaining feedback on the concept and capturing the measurable benefits it could bring. This is expected to be one of many sessions to dive deeper into the data and services needs of the community.

### **Kickoff Meeting for Pervasive Run-Time Monitoring of Emerging Hazards for UAM**

POC: [EVAN DILL](#)

On Mar. 25, a kickoff meeting was held to summarize and review plans for a new cooperative research agreement with a team from Virginia Commonwealth University and the National Institute of Standards and Technology. The agreement results from a

NASA Research Announcement solicitation. The three-year research activity encompasses the design, development, and demonstration of a pervasive run-time monitor for the detection and assessment of emerging hazards associated with heterogeneous advanced Urban Air Mobility operations. The proposed innovations include: (1) a multi-level run-time verification and monitoring capability for hazard detection; (2) a hierarchical embedded run-time assurance monitor to evaluate flight control system health; and (3) a context-dependent monitoring capability derived from data-driven learning-based techniques for the prediction of anomalies, trends, and mission risks. System validation and demonstrations will use relevant scenarios during both simulations and sub-scale flight tests. This planned work complements ongoing research in the System-Wide Safety project and during the kickoff meeting it was discussed how to best collaborate over the term of the effort.

### **System-Wide Safety Hosts Certification Panel on Autonomous Systems**

POC: [AARON DUTLE](#) AND [GUILLAUME BRAT](#)

On Mar. 30, as part of the Research Transition Team Verification and Validation subgroup, the System-Wide Safety (SWS) project hosted a third installment of the

Certification Talks series with a panel of experts on autonomy and safety assurance/certification. The safety of the increasingly autonomous systems and future paths to their certification were discussed with a group of experts from NASA, the FAA, and the Air Force Research Laboratory (AFRL). Designs for the next generation of aircraft – whether large cargo, urban air mobility, or small package delivery – invariably include increasing levels of aircraft autonomy. The assembled panel of experts discussed how the safety of these systems can be assured, as well as future paths to their certification. Aaron Dutle hosted a group of panelists virtually to discuss these issues. Panelists included Kathy Abbott, the FAA's Chief Scientific and Technical Advisor for Flight Deck Human Factors; Natalia Alexandrov, Principal Investigator in the Autonomous Integrated Systems Research Branch at NASA's Langley Research Center in Virginia; Laura Humphrey, Senior Research Engineer in the AFRL Aerospace Systems Directorate; Kerianne Hobbs, Run Time Assurance Research Lead of the AFRL Autonomous Capabilities Team; and Wes Ryan, who was with the FAA for 18 years, most recently as Manager of Research and Development for the Aircraft Certification Service, before joining the NASA Aeronautics Research Institute on Mar. 1.

# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

## NASA and FAA Kick Off Upper Class E Traffic Management RTT

POC: [JAEWOO JUNG](#)

Members of NASA and the Upper Class E Traffic Management (ETM) Research Transition Team (RTT) held their initial kickoff meeting virtually on Mar. 23. The RTT provides a structured forum for researchers and implementers to work together constructively on a continuing basis, and ensures that planned research results will be utilized to enable the implementation of NextGen air navigation services concepts. It also provides a forum for the inclusion of all NASA and FAA stakeholders in the planning and conduct of research by the RTTs and utilization of its outcomes. At the kick-off meeting, NASA and FAA team members were introduced and briefed on previously completed ETM activities, such as two tabletop exercises in 2019 and subsequent meetings with ETM community. NASA and FAA working group leads also presented their Upper Class E cooperative operations concept analysis and simulations effort. The team will meet again in April 2021 to continue conversations on the planned research activities.

## xTM Participates in DMTA RTT xTM-ATC Working Group Kickoff Meeting

POC: [PAUL LEE](#)

The Air Traffic Management Exploration eXtensible Traffic Management (xTM) sub-project xTM-ATC interactions team participated in the xTM-ATC Working Group kickoff meeting on Mar. 30. This working group is part of the Digital Mesh Technology and Applications (DMTA) Research Transition Team focusing on exploration, development, and evaluation of common methods for interaction between traditional air traffic control and xTM traffic management concepts such as Unmanned Aircraft Systems Traffic Management (UTM), small UTM, and ETM. At the kickoff meeting, the working group discussed the current and ongoing work at FAA and NASA on the topic of xTM-ATC interoperability. Sherry Magyarits of the FAA and her team presented their current analysis of xTM framework, services, and information requirements across different new entrant domains such as Urban Air Mobility, UTM and ETM. Paul Lee, NASA xTM-ATC interactions task lead, presented task objectives including identifying use cases for xTM-ATC interactions

across multiple xTM domains and developing associated roles/responsibilities, procedures, and information exchange requirements for the interactions. Both NASA and the FAA agreed that there was a significant synergy between the two tasks and discussed possible methods for close coordination in the future on their respective projects.

## Connection for Copilot Runtime Verification Framework Accepted for Release

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

The project Connector for Copilot Runtime Verification Framework (LAR-19874-1), also known as Ogma, was approved for open-source release on Mar. 31. This ten-month effort was led by Alwyn Goodloe and Ivan Perez of NASA's Langley Research Center in Virginia in close collaboration with Dimitra Giannakopoulou and Tom Pressburger of NASA's Ames Research Center in California, and Anastasia Mavridou of KBR, and engineers from Collins Aerospace. Ultra-critical systems require high-level assurance, which cannot always be guaranteed in compile time. The use of runtime verification enables monitoring these systems in runtime to detect property violations



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early and limit their potential consequences. Ogma is a tool that facilitates writing runtime monitors in existing high-level languages. It does so by taking files produced by Formal Requirements Elicitation Tool and JKind's Lustre (used by Collins Aerospace) and transforming them into hard real-time C code. Part of this work was described in

the joint paper "From Requirements to Autonomous Flight" by Dutle et al., Second Workshop on Formal Methods for Autonomous Systems. The paper describes NASA's toolchain and how it can be used in combination with Independent and Configurable Architecture for Reliable Operations of Unmanned Systems, a software architecture

for safety-centric autonomous unmanned aircraft applications built on top of NASA's core Flight System.

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### Global ADS-B Standards Document Published in the US and Europe

POC: [AARON DUTLE](#)

The third revision of the global Automatic Dependent Surveillance-Broadcast (ADS-B) standards document has been published in the US and Europe. The document caps over five years of work by the Combined Surveillance Committee, which is composed of RTCA special committees 186 and 209 and the EUROCAE Working Groups 49 and 51, and includes significant contributions by NASA. NASA's contribution includes updates to the requirements for Compact Position Reporting (CPR). These updates correct errors that were discovered by a formal analysis of the algorithm performed by the Formal Methods Group at NASA's Langley Research Center in Virginia. The group also produced a formally verified reference implementation of CPR that is included in the document's digital supplement. These additions are meant to help manufacturers to implement the CPR algorithm, which is notoriously difficult to do reliably. Another NASA contribution to the document is a set of new requirements for an air/ground determination algorithm. Aaron Dutle worked with industry partners at Garmin and Trig Avionics to develop requirements that allow an aircraft without a mechanical means (e.g. weight-on-wheels switch)

to determine air or ground status for the purpose of broadcasting the correct message type. The new requirements will provide air traffic control with more accurate information on the status of general aviation aircraft, mitigating a current issue with many aircraft broadcasting "airborne" messages while actually on the ground. The revised document was published by RTCA in the US as DO-260C on December 17, 2020 and by EUROCAE in Europe as ED-102B on January 6, 2021: <https://www.eurocae.net/news/posts/2021/january/ed-102b-mops-for-1090-mhz-extended-squitter-ads-b-and-tis-b/>.

### SWS Human Performance and Fatigue Team Contributes to Important Pilot Study

POC: [NIKUNJ OZA](#) AND [ERIN FLYNN-EVANS](#)

A paper entitled "Flight Crew Alertness and Sleep Relative to Timing of In-flight Rest Periods in Long-Haul Flights" was accepted on Jan. 11 for *Aerospace Medicine and Human Performance*, a peer-reviewed scientific journal in the field of aviation and aerospace medicine. The paper is a collaboration between the System-Wide Safety project's Human Performance and Fatigue team and researchers at Washington State University who work with United Airlines. The article will be published in the journal's February 2021 issue. The team studied approximately 600 pilots

at American Airlines and United Airlines during long haul flights and found that landing pilots have the same level of alertness whether they take the second rest break or the third rest break. This is significant because FAA regulations require pilots to take the third rest break on such flights. The team's results have led to the FAA allowing exceptions to this rule, which has been well received by pilots. The paper was written by Kevin Gregory, B.S.; Rhiannon Soriano-Smith, B.A.; Amanda Lamp, Ph.D.; Cassie Hilditch, Ph.D.; Michael Rempe, Ph.D.; Erin Flynn-Evans, Ph.D. MPH; and Gregory Belenky, M.D.

### SWS Researchers Received Acceptance of Journal Article

POC: [KYLE ELLIS](#) AND [LANCE PRINZEL](#)

On Jan. 11, System-Wide Safety researchers received final acceptance of a journal article for a special issue on modern flight decks in the *International Journal of Human-Computer Interaction* journal (to be published in the March/April 2021 issue). The article is titled "High-Fidelity Line Operational Simulation Evaluation of Synthetic Vision Flight Deck Technology for Enhanced Unusual Attitude Awareness and Recovery" and describes collaborative research by NASA and Boeing's examining the efficacy of synthetic vision (SV) primary flight displays to mitigate precursors of loss-of-control in-flight accidents and incidents. The

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research was conducted in the Level D-rated Boeing 787 Dreamliner full-motion simulator located at Boeing's Miami training facility. A series of unusual attitude recovery scenarios and a high-realism line-operational simulation scenario (gate-to-gate scenario) were employed as methods to evaluate the SV display technology. The study was conducted in response to the Commercial Aviation Safety Team's request to evaluate the technology to help mitigate the onset of unusual attitude entry due to lack of visual references, which has implications in many loss-of-control accidents. The SV technology presents a virtual analog of the outside-world visuals displayed on primary flight, navigation, and heads-up or head-worn displays. The outcome is an advanced understanding of the design of SV displays and data that informs development of Minimum Aviation System Performance Standards (DO-371) for the intended function of Aircraft State Awareness Synthetic Vision Systems. The authors are Kyle Ellis, Lance Prinzel, Daniel Kiggins, Stephanie Nicholas, Kathryn Ballard, Renee Lake, and Trey Arthur.

### SWS Participates in the AIAA SciTech 2021 Conference

POC: [MISTY DAVIES](#), [TERRY MORRIS](#), [KYLE ELLIS](#) AND [KENNETH FREEMAN](#)

System-Wide Safety (SWS) researchers were responsible for authoring and presenting at least 10

technical papers during the recent AIAA SciTech 2021 Conference. Many of the SWS researchers served on multiple panels including Misty Davies who moderated panels on "DevOps for Aerospace Software" and "Model-Based Approaches to Enabling the Future NAS." At least five researchers also served as session chairs and committee chairs during the conference. Terry Morris served as Director for the Information Systems Group, hosting a face-to-face meeting involving technical committee representatives across Intelligent Systems, Human Machine Teaming, Digital Avionics, and Software, and chaired a plenary session on "AI Drone Race I." Evan Dill served as Deputy Technical Discipline Chair for Digital Avionics and chaired multiple sessions. SWS researcher Chetan Kulkarni became an AIAA Associate Fellow. SWS also presented "A Concept of Operations (ConOps) of an In-Time Aviation Safety Management System (IASMS) for Advanced Air Mobility (AAM)," as part of an outreach effort for IASMS on Jan. 21. Kyle Ellis, Paul Krois, John Koelling, Lawrence Prinzel, Misty Davies, and Robert Mah were the authors of the paper and Kyle Ellis made the presentation at the conference. In addition, Kenneth Freeman participated in two panel discussions on cybersecurity for aerospace and space systems as part of the AIAA Cybersecurity

Working Group. The Aviation Cybersecurity Panel focused on cybersecurity education for the aeronautics domain and the Space Cybersecurity Panel discussed cybersecurity topics for space systems. Freeman discussed cybersecurity challenges in Urban Air Mobility environments and security requirements for the remote control of science experiments on space assets. Both panels had members from government, industry, and academia.

### Jon Holbrook Presents "Resilience Engineering + AAM" at HOP Summit

POC: [JON HOLBROOK](#)

Jon Holbrook of System-Wide Safety participated in the virtual Human & Organizational Performance Summit held Jan. 12–14. The theme of the summit was "learning, sharing, and connecting" and the summit focused on how to enhance organizational processes and systems to better understand and address risk. Holbrook co-presented a technical talk titled "Resilience Engineering + Advanced Air Mobility (AAM)." The talk described paths forward to enabling AAM based on resilience engineering principles that offer innovative approaches to develop and design the AAM environment and promote

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operator and autonomous systems resilient performance.

### **UAM Technical Lead Heather Arneson Participates in AUVSI Annual Summit**

POC: [HEATHER ARNESON](#)

Heather Arneson of Urban Air Mobility (UAM) served as an invited panelist at the New England Chapter of the Association of Unmanned Vehicles Systems International (AUVSI) Annual Summit, held Jan. 13–14. Focusing on the potential market for new aircraft types entering civil airspace, the panel discussed “When Will the Market Develop and What Are the Catalysts?” Arneson provided an overview of the work being done within the UAM sub-project of Air Traffic Management Exploration, discussed barriers to UAM, and talked about the research and collaborations that NASA has engaged in to address these barriers. During the Q&A period, Arneson responded to questions about companies running early-stage UAM operations with helicopters. She spoke to the benefits of engaging in this type of activity but also stressed the limitations of helicopter operations in realizing a mature UAM system. The summit was held virtually, and 70 participants attended the panel discussion.

### **SWS Researcher Evan Dill is Significant Contributor to US DOT PNT and GPS Report**

POC: [EVAN DILL](#)

System-Wide Safety researcher Evan Dill of NASA’s Langley Research Center in Virginia provided significant contributions to a recently published U.S. Department of Transportation Complementary Positioning, Navigation, and Timing (PNT) and GPS Backup Technologies Demonstration Report (January 2021). The 457-page final report describes the technology readiness level and recommendations for resilient PNT technologies that could offer complementary services in event of GPS disruptions. The demonstrations were conducted in March 2020 at NASA Langley and Joint Base Cape Cod in Massachusetts. The results are critical to addressing GPS vulnerabilities and lack of adequate backup PNT capabilities that were documented in a 2001 DOT report. The report highlighted that these issues and concerns have increased in scope and exposure to public sector reliance for critical infrastructure, emergency services, consumer and business processes, and automated systems. The findings indicate that the best strategy for achieving resilient service is to pursue multiple technologies to promote diversity

in the PNT functions that support transportation and other critical infrastructure sectors in urban, rural, and maritime areas to include current and emerging aerospace operations. More information and the report can be found here: <https://www.transportation.gov/pnt/gps-backupcomplementary-pnt-demonstration>

### **Alwyn Goodloe Attends the Machine Learning in Certified Systems Workshop**

POC: [ALWYN GOODLOE](#)

On Jan. 15-16, Alwyn Goodloe virtually attended the Machine Learning (ML) in Certified Systems Workshop organized by the Dependable, Certifiable and Explainable Artificial Intelligence for Critical Systems Project – a French and Canadian collaboration. The organizers did an excellent job of bringing together ML/statistics experts with verification expertise from around the world. The presentations began with a high-level talk by Guillaume Soudain of the European Union Aviation Safety Agency on its vision of certification issues surrounding ML. He outlined the major known issues in achieving trustworthy high-assurance ML such as lack of predictability, poor guarantees related to generalization, bias and variance in the models, and lack of robustness. The speaker was clear that before flight critical

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systems are certified, extensive experience with support systems is needed first.

Although ML systems are “trained” on a large data sets, their utility comes from the ability to generalize to input they have been trained on. Sebastian Gerchinovitz of the Institute of Technology Saint Exupéry gave an introduction to the mathematics involved, and difficulties in, characterizing mathematical bounds on the accuracy of generalization. Two technical talks focused on statistical issues in ML. Daniel Roy of the University of Toronto gave a talk on the role data plays in understanding the generalization properties of learning algorithms. Aaditya Ramdas of Carnegie Mellon University gave a talk on quantifying uncertainty for black-box classifiers. The second day provided two talks on abstract interpretation in a general introduction to the concept and how it is used in aerospace. The first talk, by Martin Vechev of the Eidgenössische Technische Hochschule in Zürich, focused on recent work that applies abstract interpretation to check a well-known robustness property of neural networks. The second talk was by Mioara Joldes of the Laboratoire d’Analyse et d’Architecture des Systèmes in Toulouse on numerical analysis issues that arise in ML optimization.

### **SWS Researcher Engages in Newly Formed Flight Safety Foundation Working Group**

POC: [JON HOLBROOK](#)

On Jan. 18, Jon Holbrook of the System-Wide Safety project engaged in a newly formed Flight Safety Foundation (FSF) Working Group (WG) on Safety-II. The goals of the FSF Safety-II WG are to: (a) formulate and align along some basic principles; (b) facilitate the networking and cooperation; and (c) enable the elaboration of joint knowledge resources. Holbrook currently leads the System-Wide Safety Human Contributions to Safety team, which is focused on research to apply resilience engineering and new safety thinking (Safety-II) concepts, principles, and practices to inform present and emerging aviation operations safety and autonomous systems design.

### **ATM-X Uniform Control for VTOL Aircraft - 2021 Autonomous VTOL Technical Meeting**

POC: [JACOB COOK](#) AND [IRENE GREGORY](#)

On Jan. 27, Jacob Cook of NASA’s Langley Research Center in Virginia presented a paper he co-authored with Irene Gregory entitled “A Robust Uniform Control Approach for VTOL Aircraft” at the Ninth Biennial Autonomous Vertical Take-Off and Landing (VTOL) Technical

Meeting. The paper details recent work towards enabling safe flight for Urban Air Mobility (UAM)-class vehicles at NASA Langley under the UAM sub-project in support of developing separation standards for Advanced Air Mobility. The paper also builds on related research conducted in collaboration with the Transformational Tools and Technologies project’s Resilient Autonomy (TTT-RA) Autonomous Systems (AS) sub-project, published as part of the 2021 AIAA SciTech Forum (“Examination of Unified Control Approaches Incorporating Generalized Control Allocation”). The presentation was given during a session dedicated to Flight Dynamics, Controls, and Simulation of VTOL aircraft with approximately 70 live participants, and generated much interest.

### **Holbrook Participates at British Airline Pilots Association Webinar**

POC: [JON HOLBROOK](#)

On Feb. 1–2, Jon Holbrook of System-Wide Safety (SWS) participated as an invited virtual speaker and panelist for “Building Learning Airlines for Safety Improvement,” a webinar hosted by the British Airline Pilots Association. The goal of the event was to discuss the theory, practice, and regulation behind building “learning airlines” for safety improvement. Holbrook

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discussed the SWS project team's work focused on systematically collecting, analyzing, and learning from safety-producing behaviors in a presentation titled "How Safety Thinking Impacts Safety Learning: Creating Opportunities to Learn." More than 200 attendees participated in each day of the webinar.

### SWS Participation in SAE S-18 Standardization Activities

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

On Feb. 1-5, Mallory Graydon participated virtually in the quarterly meeting for SAE International's S-18 Committee. The SAE S-18 is updating and drafting several aerospace-related documents and standards including: (a) the ARP4754B safety management standard; (b) the ARP4761A hazard analysis standard; (c) the AIR7209 paper on safety principles for aerospace vehicles and systems; (d) the AIR7121 paper on the applicability of existing development assurance and system safety practices to unmanned aircraft systems; (e) the AIR6276 paper on the use of modeling and tools for aircraft systems development assurance; and (f) the AIR6276 paper on the use of the Systems Theoretic Process Analysis (STPA) in aerospace applications.

Related link: <https://www.sae.org/works/committeeHome.do?comtID=TEAS18>

### ATM-X Presentation at Aerial Connectivity Joint Activity

POC: [RAFAEL APAZA](#)

On Feb. 3, Davis Hackenberg of the Advanced Air Mobility (AAM) Mission Integration Office and Rafael Apaza of NASA's Glenn Research Center in Cleveland gave a presentation on AAM and the NASA Announcement of Collaborative Opportunity, CNS Annex at the Aerial Connectivity Joint Activity (ACJA) monthly meeting. The ACJA forum promotes information exchanges between the aviation and cellular communications communities and synchronizes contributions between the existing Standard Development Organizations of each community. The briefing objective was an outreach effort to increase AAM and partnership opportunities awareness. NASA's presentation introduced AAM and focused on wireless communications challenges, CNS work plans, and described the CNS Annex flight testing process. Participants included telecommunications service providers, communications manufacturing and aviation industry representatives.

### UAM Technical Leader Virtual Visit with Univ. of Illinois Aerospace Engineering Department

POC: [HEATHER ARNESON](#)

On Feb. 15, Heather Arneson was invited by her graduate alma

mater, University of Illinois at Urbana-Champaign, to be the guest speaker at the Aerospace Engineering Department's virtual seminar. Arneson gave an overview of the Urban Air Mobility (UAM) sub-project and shared some preliminary research results from the Airspace Services focus area. More than 100 attendees were online for her presentation, including faculty and students. In addition to the seminar, her virtual visit included conversations with 11 faculty and staff members and a conversation with graduate students following the seminar. Faculty at the university are working on a broad range of problems that are highly relevant to the UAM work being done at NASA. Discussions focused on topics in the public domain, such as the operation of new vehicles designed for UAM in close proximity, methods to gather data for prediction and modeling of micro-weather in urban landscapes, machine learning for mission planning, machine learning to identify precursors to safety events, coordination of safety-critical autonomous systems, and verification of cyber-physical systems.

### NASA Ames Honorees in the 2020 Federal Employee of the Year Awards

POC: [JOSEPH RIOS](#)

On Feb. 18, Joseph Rios was one of seven employees from NASA's Ames Research Center in California

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recognized at the San Francisco Federal Executive Board (SFFEB) 2020 Federal Employee of the Year Awards hosted in San Francisco. The SFFEB represents 160 agencies and 44,500 federal employees in the nine-county San Francisco metropolitan area. The Federal Employee of the Year Awards is the San Francisco-area federal community's acknowledgement of the extraordinary accomplishments of the nominees. Rios won in the Science and Technology category for leading the technical development of a revolutionary approach to safely and efficiently integrating a new class of aircraft into our skies. The system enables a future where drones are routinely used for public safety, infrastructure inspections, agricultural needs, deliveries, mapping, and other tasks beneficial for society.

### **NASA/FAATC Partnership Described in ATCA Journal of Air Traffic Control**

POC: [IAN LEVITT](#)

As part of a recently signed Interagency Agreement (IA1-30149, Annex 3), NASA's Langley Research Center in Virginia and the FAA William J. Hughes Technical Center (FAATC) are partnering to integrate laboratory assets and tools to develop Research, Development, and Test and Evaluation capabilities to evaluate emerging Advanced Air Mobility

(AAM) operational concepts and associated technologies. This partnership is described in the cover story featured in the winter 2020 edition of the Air Traffic Control Association's Journal of Air Traffic Control. The article, entitled "The FAA's Research, Development, Test & Evaluation Environment of the Future," highlights how initial laboratory integration with NASA Langley assets – including the Air Traffic Operations Lab, the Urban Air Mobility Vehicle Simulation (known as the "UAM Flyer"), the UAM Mission Planner, and the City Environment Range Testing for Autonomous Integrated Navigation – will expand the FAATC's baseline Trajectory Based Options Integrated Test Environment. The FAATC's National Airspace System laboratory assets include the Standard Terminal Automation Replacement System, out-the-window tower lab, Unmanned Aircraft Systems (UAS) lab, Cockpit Simulation Facility, UAS Traffic Management (UTM), and real-time and fast-time simulation capabilities. As a result of laboratory integration between NASA Langley and the FAATC, a collaborative Advanced Air Mobility Live, Virtual, and Constructive Environment with Air Traffic Management, UAM, and UTM simulation capabilities will be established resulting in an increased level of readiness to conduct future National Airspace System concepts.

### **AOSP Projects Participate at the SAE AeroTech Seminar**

POC: [WILLIAM CHAN](#), [NATASHA NEOGI](#)  
AND [JOHN KOELLING](#)

Two Airspace Operations and Safety Program projects participated at the SAE AeroTech Seminar on Mar. 10. Air Traffic Management Exploration conducted a project overview, which was moderated by the Advanced Air Mobility (AAM) Mission Integration Office and included project managers from AAM, System-Wide Safety (SWS), and Revolutionary Vertical Lift Technology. SWS also participated in the AAM Track with Natasha Neogi and John Koelling as panelists. Neogi served on the AAM Use Cases and Public Acceptance panel. Members on the Public Acceptance Panel spoke regarding multiple use case scenarios such as medical emergency, agriculture, and search and rescue. Additionally, concerns related to safety, community engagement, and diversity and inclusion of services to persons with disabilities were discussed in detail. The AAM Ecosystem Alignment Session Panel included SWS project manager John Koelling, who discussed the diverse technology contributions NASA is making to the AAM Ecosystem by providing an overview on project activities and key innovations across NASA that will make AAM a reality. The session highlighted technology transfers to standards organizations, FAA, and industry.

## RECOGNITION

### **CAS/ATM-X Projects' Donna Gilchrist Honored for Black History Month**

POC: [WILLIAM CHAN](#)

On Mar. 24, Donna Gilchrist of the Convergent Aeronautics Solutions and Air Traffic Management

Exploration projects was honored among those featured as part of Black History Month on NASA Aeronautics' website. Donna Gilchrist works as a scheduler for both projects. One of the significant contributions Gilchrist made, amongst several others, was to provide mentorship to

students and advise them on how to overcome obstacles while pursuing a career in STEM.

Website: <https://www.nasa.gov/aeroresearch/programs/tacp/cas/donna-gilchrist-honored-for-black-history-month>



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