



# AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

OCT-DEC 2020 | Quarter 1



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## AOSP IN THE NEWS

### **NASA's STEReO: Air Traffic Management for Emergency Response**

Drone Life (Oct. 23) reports “As emergency managers readily adopt the use of drones to aid in the response to natural disasters such as wildfires and hurricanes, the skies above those disaster zones are becoming increasingly crowded with aerial vehicles, both manned and unmanned, creating the need for an automated aerial traffic cop. Enter NASA, whose Ames Research Center in California’s Silicon Valley is leading the way, with the development of the Scalable Traffic Management for Emergency Response Operations, or STEReO project.”

### **NASA Gears Up for Advanced Air Mobility eVTOL Flight Testing**

Aviation Week (Nov. 13) reports “Preparations for the first in a series of flight trials to help ensure the safety and accelerate the scalability of urban air mobility are gathering

pace at NASA Armstrong Flight Research Center in California. NASA gears up for eVTOL flight testing under Advanced Air Mobility National Campaign...”

### **Wisk Teams with NASA on Autonomous Urban Air Mobility**

Aviation Week (Nov. 16) reports “Self-flying air-taxi developer Wisk has teamed with NASA to address the safe integration of autonomous aircraft into urban airspace. The partnership will support NASA’s Advanced Air Mobility National Campaign. The National Campaign (NC) will conduct simulations and flight tests to develop guidance...”

### **NASA/FAA UAS Demonstrations Mark End of UTM Pilot Program**

ATCA Headline News (Nov. 17) reports “the second phase of the Federal Aviation Administration’s (FAA) unmanned aircraft systems (UAS) traffic management pilot

program (UTM/UPP) ended with testing demonstrations in partnership with the National Aeronautics and Space Administration (NASA) focused on testing remote identification (RID) technology and beyond visual line of sight (BVLOS) operations, according to a Nov. 17 press release.”

### **NASA Teams Reach Milestones in Drone-Related Flight Programs**

Drone DJ (Dec. 23) reports “In an overview of the year, American space agency NASA has shared a few drones and drone-related milestones its flight team has had. Along with the usual space-related work NASA is known for, it also works on many drone projects to advance future use of the technology. The massive list of milestones the agency has achieved over the last year is impressive, especially in spite of the COVID-19 pandemic.”

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

### **NASA and Boeing Complete Phase I Collaborative Flight Simulation Study**

POC: [CHAD STEPHENS](#), [LANCE PRINZEL](#)  
AND [JON HOLBROOK](#)

On Nov. 14–16, researchers Chad Stephens, Lance Prinzel, and Jon Holbrook of NASA's Langley Research Center in Virginia completed a human-in-the-loop flight simulation study at the Boeing Commercial Flight Training Campus in Miami. The team of researchers remotely collaborated with System-Wide Safety (SWS) project contractor team member Dan Kiggins of San Jose State University and Boeing researchers Beth Biddle, Research & Technology; and Jim Wilkerson, Standards and Training. Three commercial aviation flight crews were recruited to participate in the study, which involved the performance of four area navigation standard terminal arrival route (RNAV STAR) arrivals into Charlotte Douglas International Airport using the Boeing 737NG full flight simulator. The focus of the research study was to collect and analyze data on how commercial aviation flight crews handle routine expected and unexpected disturbances in commercial flight

operations, exploring human productive contributions to safety (HC2S). The objective of the Phase I study was to understand the factors involved in productive safety demonstrated by flight crews using safe and necessary non-adherence to RNAV STAR arrivals as the operational example. The study involved experimental methodologies applied during and after the scenarios were performed, including video recording and analysis of flight crew behaviors, such as eye tracking, and the completion of surveys and interviews. Data was also collected for team members on the SWS HC2S project, researchers Dorrit Billman and Alan Hobbs of NASA's Ames Research Center in California. Phase II data collection will focus on additional methods to study resilient, safety-producing behaviors of flight crews to better inform development of new training approaches. The SWS project has world-renowned experts in aviator resilience and safety-producing behaviors. Under Space Act Agreement SAA1-23831, SWS researchers are working together with Boeing and various airlines to better understand human contributions to safety in various facets of commercial aviation.

### **IASMS Research Transition Team Kickoff Meeting with the FAA**

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

The System-Wide Safety project's In-Time Aviation Safety Management System (IASMS) Concept of Operations (ConOps) development team met with FAA technical leadership on Oct. 1 to kick off the IASMS Research Transition Team (RTT) ConOps sub-group. The IASMS RTT ConOps sub-group is responsible for ensuring a close relationship between NASA and the FAA in expanding the IASMS concept collaboratively developed by NASA and the broader global aviation industry during the past two years. Version 1 of the IASMS ConOps was published in June 2020 with a focus on the Urban Air Mobility operational domain. The Aeronautics Research Mission Directorate has requested the concepts presented in that initial publication be expanded and applied to transform the overall National Airspace System across all envisioned future operational domains. The ConOps sub-group will deliver a Version 2 of the expanded IASMS ConOps published jointly by NASA and

## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

the FAA. The IASMS RTT ConOps sub-group members include co-chair Kyle Ellis, Jessica Nowinski, Lawrence Prinzel, Robert Mah, and Paul Krois (consultant) representing NASA, and co-chair Timothy Evans, Scott LeMay, Aleta Best, and Richard Pittaway representing the FAA. The IASMS concept of operations supports ARMD's Strategic Thrust #5, "In-Time System-Wide Safety Assurance," with reference research and development executed under the System-Wide Safety project.

### ATD-2 Fuser Technology Now Available via NASA Open Source Agreement License

POC: [JANE THIPPHAVONG](#)

On Oct. 13, the Airspace Technology Demonstration 2 (ATD-2) team released a core component of its software known as the "Fuser" under an open-source license on GitHub (NASA Open Source Agreement v1.3). In collaboration with the National Air Traffic Controllers Association, FAA, and industry over the past five years, NASA has developed and operated an integrated arrival, departure, and surface (IADS) traffic management system for complex terminal environments. The Fuser provides a foundational service to the ATD-2/IADS components by consolidating many different sources of aviation data into a single, mediated source

for use by other traffic management software components. To accomplish this, the Fuser aggregates multiple FAA data sources, airline data, and third-party data into a single harmonized source. All information that's gathered is organized by individual flight (i.e. one takeoff and one landing) using the Globally Unique Flight Identifier as the key. As each new message is received by the Fuser, the fused flight is updated. Clean and accurate data is assured through the use of transformation and mediation processes that enforce business rules on the received data. ATD-2 components rely on the Fuser database as a "System of Record," providing a single interface for access to data from many different origins. The Fuser software provides a service common to many facets of the aviation industry. Industry feedback received during System Wide Information Management Industry - FAA Team meetings and the ATD-2 Industry Workshop highlighted the challenge of managing multiple aviation data sources for use in traffic management systems. By releasing the Fuser source code under an open source agreement, NASA provides industry direct access to the Fuser technology that has been refined over many years.

Additional information on the Fuser and the functionality it provides can be found here:

[https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/fuser/ATD-2-Industry-Workshop-Documentation-Outline\\_81565170.html](https://aviationsystems.arc.nasa.gov/atd2-industry-workshop/fuser/ATD-2-Industry-Workshop-Documentation-Outline_81565170.html)

ATD-2 Fuser GitHub page: <https://github.com/nasa/atd2-fuser>

### NASA Presents ASRS-UAS Safety Reporting Capability at UAS Team Plenary

POC: [BECKY HOOEY](#) AND [MISTY DAVIES](#)

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

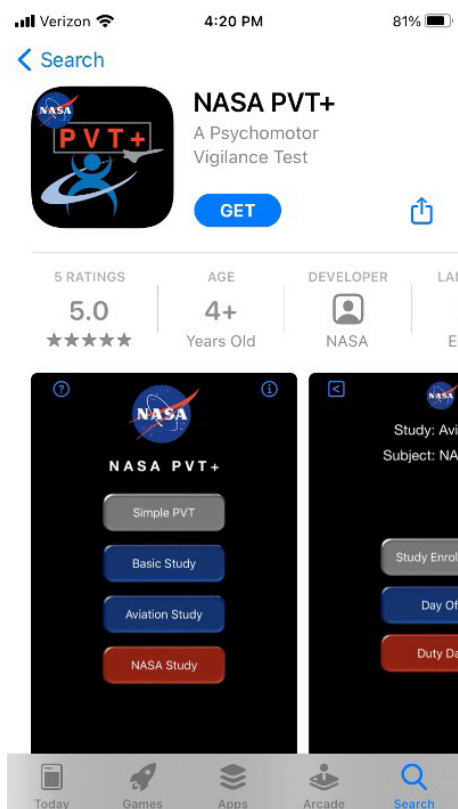
## TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

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.

### Fatigue Tracking App Now Available in the Apple App Store

POC: [ERIN FLYNN-EVANS](#) AND [MISTY DAVIES](#)

On Oct. 16, the Fatigue Counter Measures Lab within the System-Wide Safety project, led by Erin



*NASA PVT+ App*

Flynn-Evans of NASA's Ames Research Center in California, has released the NASA Psychomotor Vigilance Task (PVT+) app, now available for free in the Apple App Store. The app provides a tool to assess a participant's fatigue level on a real-time basis and support research on the point at which fatigue impacts alertness. All data is stored locally on the device that the participant uses to collect the data – not in the cloud or NASA. Most importantly, the app does not collect any personally identifiable information. The app represents a years-long culmination of research and development ensuring that the PVT test would replicate the types administered in labs. The app also provides an opportunity to have consistent and reliable data among airlines and research institutions studying fatigue to improve the ability to generalize results across studies.

### ATD-2 Ramp Traffic Features Included in Aerobahn User Tool for TFDM

POC: [YOON JUNG](#)

On Oct. 21, ATD-2 researchers participated in the second Aerobahn Terminal Flight Data Manager (TFDM) workshop, hosted by Saab Sensis Corporation. Saab Sensis is developing a tool powered by their Aerobahn product providing users with an interface to communicate with TFDM. The goal of the workshop was to bring together

future users identified by the FAA's early TFDM implementation waterfall, including major airlines and airports, to provide updates on the user tool and solicit feedback. The design of the ATD-2 Ramp Traffic Console and Ramp Manager Traffic Console has been transferred to the FAA and industry as part of the ATD-2 technology transfer during the past five years. Saab Sensis incorporated features from NASA's ATD-2 Ramp Consoles in the Aerobahn user tool, including the surface metering indicator and flight data tag. During the meeting, Saab Sensis conducted a comprehensive demonstration using simulated traffic at Los Angeles International Airport. The Aerobahn tool also includes updating airlines' earliest off-block times and substitution requests for surface metering programs, as well as displaying target off-block times and target movement area entry times generated by TFDM. The main display of the user tool consists of a flight table, map display, and surface metering statistics. The flight table lists the flights affected by the surface metering program and allows airport ramp personnel to monitor the status of each departure, update earliest off-block times, or submit substitution requests to TFDM. The map display shows aircraft parked at gates and taxiing. The workshop allowed for fruitful collaboration

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among various stakeholders and a follow-on meeting is planned for early next year.

### Scenario 1-Tested NPSU Delivered to National Campaign

POC: [ARWA AWEISS](#)

On Oct. 29, the Air Traffic Management Exploration project's Urban Air Mobility (UAM) Airspace Management sub-project team successfully released a version of an airspace management system for UAM. The NASA Provider of Services for UAM (NPSU) was delivered to the Advanced Air Mobility project's National Campaign (NC) sub-project for testing. The NPSU is a newly developed software component designed and developed by the UAM team for use in flight test events such as NC Developmental Testing and other planned NC events, as well as other research activities internal and external to the UAM sub-project. UAM will continue to develop the NPSU to provide additional functionalities needed by NC and release the NPSU in an iterative manner to reduce the overhead necessary for integration.

### Acoustics Technical and UAM Noise Working Group Meeting

POC: [JINHUA LI](#)

On Nov. 5, the Urban Air Mobility (UAM) sub-project within the Air Traffic Management Exploration

project unveiled its latest work utilizing AIRNOISE-UAM, a NASA-developed tool that models and predicts the local and regional noise impact of UAM operations. In a virtual presentation at the Acoustics Technical and UAM Noise Working Group meeting hosted by NASA's Glenn Research Center in Cleveland, Jinhua Li of NASA's Ames Research Center in California presented a noise-aware flight planning capability that leverages the AIRNOISE-UAM capability. The presentation drew more than 100 attendees from the FAA, NASA, and industry. The audience expressed interest in the availability of AIRNOISE-UAM outside NASA. The working group's focus is to reduce or eliminate the impacts of UAM noise on the community, and its next meeting will be held in April 2021. AIRNOISE-UAM was developed in collaboration with NASA's Revolutionary Vertical Lift Technology project, which developed the aircraft noise model.

### SWS Holds Collaboration Meetings with American Airlines

POC: [LANCE PRINZEL](#), [MISTY](#)

[DAVIES](#), [CHAD STEPHENS](#)

AND [IMMANUAL BARSHI](#)

The System-Wide Safety (SWS) project held several collaboration meetings with American Airlines during the past quarter. The SWS project team conducted a comprehensive preliminary needs

assessment to help identify airline industry COVID-19 responses and recovery needs. As part of the assessment, collaborative efforts have begun to determine what existing knowledge, skills, and capabilities or ongoing efforts can be leveraged to provide near-term, exigent help to airlines. SWS project leadership and researchers met with safety captains, managers, and executives from American Airlines to better understand the needs of the airline, and initiate coordinated planning efforts focused on mutually agreed upon solutions. The first collaboration meeting, held on Oct. 1, was a continuation of these efforts and focused on further discussions to target potential areas of support. The result of the meeting was an identification of ways in which NASA and American Airlines could collaborate and partner on specific airline needs. The multi-center meeting with American Airlines personnel included Ron Thomas, Vice President of Safety; Neil Raaz, Director of Operations Safety; John Duncan, Director of Flight Training and Standards; Guy Mouton, Senior Manager for Safety Management System and Line Operations Safety Audits; David Hitte, COVID-19 Response Team; Deborah Decker, Chief Pilot at Dallas-Fort Worth International Airport; Ted Rogachuk, Manager of Safety; and John Dudley, Managing Director of Flight Operations. Eleven NASA team members

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participated, including the project leadership team and technical leads.

A follow-on meeting was held Nov. 5 in which SWS researchers and American Airlines safety representatives met for a working group brainstorming session. The group discussed the causal factors associated with specific safety events increasing in incidence during pre-flight and push-back that the airline has observed in Aviation Safety Action Program reports. Safety data and incident reports indicate a significant increase in the number of errors made during completion of checklists and other procedures. SWS experts are working together with various airlines' safety departments to better understand the reason for the increase in safety events and identify possible prescriptions to countermand them. A detailed approach to addressing the problem and a set of potential approaches were agreed to at this meeting. Collaborative efforts are continuing as part of a larger SWS project effort to help the airlines with safety issues due to COVID-19 impacts and return-to-service concerns.

### AdaStress Tool Helps Identify Error in ACAS-Xu

POC: [GUILLAUME BRAT](#) AND [RITCHIE LEE](#)

System-Wide Safety's AdaStress tool helped the project team identify a serious error in the reference implementation for the Airborne

Collision Avoidance System X unmanned (ACAS-Xu), the ACAS version for remotely piloted aircraft systems, incorporating horizontal resolution maneuvers. The System-Wide Safety team is submitting this report to the Johns Hopkins team implementing ACAS-Xu for the FAA in November. The AdaStress team was the first to identify the issue. Innovations on adaptive stress testing by Ritchie Lee of NASA's Ames Research Center in California are a key step towards making the software development process safer and making it easier to catch subtle problems before deployment. Last summer, due to previous successes, Lee was asked to collaborate with the Johns Hopkins Applied Physics Laboratory development team, which is developing the reference versions of ACAS-X for the FAA, to help with the verification and validation of ACAS-Xu. While applying AdaStress, Lee and his assistant Rory Lipkis showed that the code was generating coordination conditions correctly, but did not act on the received coordination correctly. Specifically, the system was not recognizing the opposing intruder as a Master, and thus would not defer to their coordination. Lee's team was the first one to unearth this problem, which has since been corrected for the next version of ACAS-Xu. The new version is a significant achievement because it will serve as the reference implementation for industry to develop a commercial version of ACAS-Xu.

### NASA/FAA Human Factors RTT Panel Discussion on AAM

POC: [JON HOLBROOK](#) AND [MISTY DAVIES](#)

Jon Holbrook of NASA's Langley Research Center in Virginia and Bill Kaliardos of the FAA moderated a panel discussion at the System-Wide Safety Human Factors Research Transition Team (HF RTT) meeting on Nov. 10. The HF RTT will use information garnered from this activity to coordinate cross-agency human factors research efforts. Panelists included Wes Ryan and Nouri Ghazavi of the FAA, Kenneth Goodrich and Natasha Neogi of NASA Langley, and Mike Feary of NASA's Ames Research Center in California. The goal of the HF RTT is to identify and prioritize specific human factors/human-systems integration research issues and gaps in Advanced Air Mobility. Panelists were asked to provide their perspectives on Advanced Air Mobility and the critical gaps in knowledge that need to be filled to enable it. Panelist briefings were followed by open discussion with attendees, including civil servant human factors researchers from NASA and the FAA.

### ATD-2 Phase 3 Update for Collaborative Decision Making General Session

POC: [JEREMY COUPE](#) AND [GREG JURO](#)

On Nov. 17, Airspace Technology Demonstration-2 (ATD-2) partners provided an update on

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the Phase 3 Field Demonstration at the 2020 Collaborative Decision Making (CDM) Annual General Session meeting. CDM is a joint government/industry initiative aimed at improving air traffic flow management through increased information exchange among aviation community stakeholders. Two CDM teams (Surface CDM team and Flow Evaluation team) have a joint task to work with NASA to facilitate the transfer of ATD-2 knowledge and technology. These two teams include representatives from most US air carriers (cargo and freight), business aviation, academia, several major airports, and the FAA. The briefing updated the CDM community on accomplishments from the past year and outlined steps being taken to ensure maximum impact from a FY 2021 project extension that was granted due to the impact of COVID-19. Highlights of the briefing included a shift in strategy for training from in-person to a 100% virtual training environment starting in March 2020 and the development of tailored online training videos and material for each field facility. Collaborative tabletop exercises are being conducted with the airline operators as an additional training tool, and to better understand their decision-making and internal coordination processes required to submit Trajectory Options Set (TOS) reroutes. New TOS metrics

were presented that highlight the increased number of use cases that these metrics will enable, including the aggregate system level benefits and the probability of delay savings exceeding the relative trajectory cost. Additionally, the introduction of a new use case was outlined, extending the TOS concept from the origin departure airport all the way to the downstream arrival airport. Lastly, the briefing described NASA's strategy for developing and transferring a suite of machine learning microservices that embody the core capabilities of the ATD-2 surface trajectory-based operations surface model. Machine learning services will form the building blocks of a scalable National Airspace System TOS digital reroute capability and are intended to be transferred to the FAA, industry, and the aviation community.

### **Future PAAV Simulation to Work With FAA**

POC: [ROB FONG](#)

The Pathfinding for Airspace with Autonomous Vehicles (PAAV) sub-project, part of the Air Traffic Management Exploration project, completed four informal interviews with FAA representatives to understand their perspectives with respect to challenges for integrating unmanned aircraft cargo into the National Airspace System. The final interview was completed on Nov. 20

and included members from Flight Standards, Air-Traffic Organization, and the FAA William J. Hughes Technical Center. PAAV will use the insights obtained from the interviews to bolster research questions.

### **Community Integration Working Groups Meeting**

POC: [IAN LEVITT](#)

On Dec. 3, one of a series of meetings of the Community Integration Working Group: Supplemental Data Service Providers (SDSP) took place. This meeting focused on the topic of weather and was co-hosted by the Airspace Working Group. These groups are two of the four Advanced Air Mobility Ecosystem Working Groups that kicked off in the spring of 2020. Three speakers presented at this meeting. The first, Marcus Johnson of NASA's Advanced Air Mobility project, shared SDSP lessons from the Unmanned Aircraft Systems Traffic Management (UTM) Concept of Operations. Ian Levitt, principal engineer of the Urban Air Mobility (UAM) sub-project, provided an overview of weather impacts to airspace services and SDSP, as well as the current gaps in UAM research, development, test, and evaluation. The final speaker, Edward Lester from AiRXOS (part of GE Aviation), discussed SDSP and UTM Service Suppliers interactions in the UTM



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environment. The meeting was livestreamed on YouTube and attended by 105 participants. The Community Integration Working Group forum encourages dialogue with industry on issues facing the UAM community. As part of a series on weather, this meeting provided the Air Traffic Management Exploration project the opportunity to bring real-world assumptions into the research environment. The importance of “shifting left” in the area of weather-related services was highlighted as essential to successful commercialization and operation of the UAM concept.

### **ATM-X CTM Sub-Project Holds Meetings with Stakeholders**

POC: [JAEWOO JUNG](#)

The Air Traffic Management Exploration (ATM-X) project’s Collaborative Traffic Management (CTM) sub-project Upper-E Traffic Management (ETM) team held several meetings with stakeholders this past quarter. The first meeting was with Swift Engineering on Oct. 6. During the meeting, Swift Engineering provided information regarding their support of NASA’s Science Mission Directorate, particularly the High Altitude Long Endurance (HALE) unmanned aircraft being developed. The ATM-X project is working with the FAA in maturing the ETM Concept of Operations (ConOps)

Version 1 published in May 2020. Understanding HALE operations provides valuable information as part of this effort. Further discussions are planned in the near future.

On Oct. 23, the CTM team met with representatives from the FAA and industry in one of a series of meetings to discuss ETM concepts and develop them further. In this meeting, the industry’s approach to cooperative operation plan conflict identification, negotiation for equitable access, the FAA’s ETM ConOps maturation approach, and NASA’s fast time simulation capability were discussed. A follow-on meeting was tentatively scheduled for December 2020.

Subsequently, the CTM team presented their work at the fourth Federal Unmanned Aircraft Systems (UAS) workshop held Nov. 17–19 by the United States Geological Survey National Innovation Center. According to the workshop organizer, “this online event will showcase progress reports from federal partners, new technology capabilities going forward in industry, standardization efforts, and growing the domestic UAS industry with Defense Innovation Unit.” The CTM team discussed their approach in ETM research and development as part of the emerging new technology track on Nov. 18, presenting an overview

of research currently underway for ETM. The presentation followed the day’s first session that was dedicated to presentations from four HALE aircraft companies and their updates on development and testing. The combination of these presentations and the maturity of platforms highlighted the importance of the ATM-X CTM work to develop an airspace management approach for Upper Class E airspace.

As a follow-on to the Oct. 23 meeting, the ETM team met again with representatives from the FAA and industry on Dec. 10 – the latest in a series of gatherings to discuss and further develop ETM concepts. At this meeting, the industry’s approach to cooperative operation intent conflict identification and negotiation for equitable access was discussed further as a continuation of the October conversation. A scenario involving a balloon and a HALE unmanned aircraft with plans for operations in the same airspace at the same time was presented, and ways to resolve the potential operational plan conflict were discussed. NASA’s ETM modeling and simulation effort for next year was also presented and discussed. A follow-on meeting was scheduled tentatively for February 2021.

# TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

## PAAV Sub-Project Publishes Request for Information

POC: [ROB FONG](#)

The Pathfinding for Airspace for Autonomous Vehicles (PAAV) sub-project within the Air Traffic Management Exploration project published a Request for Information (RFI) on Dec. 10. The objective of the RFI is to learn about industry plans to invest in remotely piloted and autonomous cargo operations, understand the challenges that must be addressed, and help PAAV determine a comprehensive partnership strategy to engage industry. PAAV is specifically interested in potential industry partnerships to help guide the development of a comprehensive concept of operations for commercially viable operations, which will guide NASA research as well as potential partnerships to conduct collaborative flight tests and demonstrations with NASA. The response date for this RFI is January 29, 2021.

## UAM X-3 Scenario-3 Testing with Industry Partners Completed

POC: [SPENCER MONHEIM](#)

On Oct. 30, the Air Traffic Management Exploration Project's Urban Air Mobility (UAM) sub-project started its third and final phase of testing in the X-3 series of lab tests with airspace partners to

prepare them for the Advanced Air Mobility National Campaign (NC) scheduled for 2022. This phase of testing will focus on NC Scenario-3 that involves contingency use cases for aircraft landing on the surface of the airport, such as requiring a UAM flight to perform a go-around or land on an alternate flight pad due to the primary landing pad being occupied. All of these use cases will require the industry partners to re-plan their original operations mid-flight. X-3 testing started with Scenario-1 on Aug. 30 and allowed industry partners to schedule their data collection on any available scenario through December based on their readiness. Scenario-2 was made available Sept. 30. On Oct. 21, industry partners were briefed on the test procedures for Scenario-3 that will be required prior to commencing Scenario-3 data collection scheduled for Oct. 30. At that time, partners were able to schedule Scenario-3 for data collection.

On Dec. 10, testing for the X-3 simulation with the National Campaign airspace partners was successfully completed. Airspace partners included Avison, Anra, Onesky, University of North Texas, Metron, Uber, AirXos, Collins, GeoRq, Ellis and Associates, and Airmap. Testing with airspace partners was the capstone component of the X-3 simulation, in which private sector partners demonstrate their capabilities in

managing UAM operations in a simulated airspace. Data collected in the X-3 simulation serves a multitude of purposes, including helping the selection of NC-1 airspace partners for the X-4 simulation in 2021 and NC-1 flight test in 2022; providing valuable research data to NASA, FAA, and industry; and helping to define improvements that needed in the airspace system for X-4 and NC-1 flight test. Three scenarios were selected for X-3, with an expectation that most airspace partners would not be advanced enough in their airspace systems to complete all three scenarios. Despite this, two airspace partners completed all three scenarios, four partners completed or partially completed two scenarios, and seven partners completed or partially completed at least one scenario.

## DARPA Automated Rapid Certification of Software Project First Phase Review

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

System-Wide Safety team members Mallory Graydon, Paul Miner, and Natasha Neogi participated in the extensive government review of the first phase of work in the Defense Advanced Research Project Administration's Automated Rapid Certification of Software (DARPA ARCOS) project. ARCOS is investigating technologies

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for producing, managing, and documenting certification evidence in the form of safety cases. The review of ARCOS participants' progress and products will help ensure the government's need is met for facilitating rapid, cost-effective certification of safety- and security-critical software intensive systems. The government panel review was held virtually in eight sessions of two hours each beginning Nov. 30 and ending Dec. 10. Additionally, the group attended the ARCOS principal investigator meeting held virtually Dec. 14-15.

### **ATD-2 Conducts Stormy 2021 Training Exercises with Flight Operators**

POC: [GREG JUR0](#)

The Airspace Technology Demonstration-2 (ATD-2) team conducted several Stormy 2021 training sessions this past quarter. The first interaction for the team was with American Airlines and Southwest Airlines on Oct. 6 and Nov. 16, respectively. Both exercises were conducted virtually and remote connections to the ATD-2 system were utilized. The tabletop exercises were designed to simulate flight operators' use of the Trajectory Option Set technology embedded in the ATD-2 system. These exercises are being utilized as a training resource in addition to the hands-on and video training that has been previously provided. Realistic

traffic and weather scenarios were simulated that resulted in the flight operators assessing reroute opportunities to reduce delay. The team used the opportunities created by the simulations to reinforce important aspects of the ATD-2 system, including the elements that provide accurate and timely information to assist in making informed and beneficial reroute decisions. Additionally, the flight operators relayed valuable information to the ATD-2 team on the coordination they must accomplish when assessing and submitting a reroute.

A follow-on tabletop session was scheduled for the first three weeks of December. The session included seven sessions of virtual training to Air Traffic Coordinators at Envoy Air and Traffic Management Coordinators (TMC) at Dallas Fort Worth International Airport (DFW) tower. Four training sessions were conducted with the coordinators at Envoy Air, and three were conducted with TMC's at DFW Tower. Training sessions for Envoy Air included an overview of the objectives of ATD-2, Phase 3, demonstrations of ATD-2's various tools, and extensive instruction on using TOS tables – designed to make it easy for the flight operator to identify a flight that could be rerouted to attain efficiency benefits. The training sessions for DFW tower included detailed

explanations of the new elements recently added to ATD-2, as well as refresher training on how to approve a Trajectory Option Set request submitted by the flight operator. Additionally, the training sessions emphasized the benefits of entering a taxi plan into the ATD-2 system as far in advance as operationally feasible. Finally, a demonstration was provided on how flight operators utilize aggregate delay savings to assess the benefits of submitting a reroute.

## RECOGNITION

### SWS Deputy Moderates AAM Ecosystem Crosscutting Working Group – Autonomy Needs Panel

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

On Oct. 7, Misty Davies, deputy project manager for the System-Wide Safety project, moderated a panel of experts at the Advanced Air Mobility (AAM) Ecosystem Crosscutting Working Group – Autonomy Needs panel. The panel of experts included Lael Rudd and Ella Atkins of the National Academies Committee for Autonomy Research in Aviation; Léonard Bouygues, Head of Aviation Strategy at Loon; Hunter Hudson, Head of Autonomy Technology at Northrop Grumman; and Parimal Kopardekar, director of the NASA Aeronautics Research Institute. The panelists shared their views on autonomy and its role for the proposed Urban Air Mobility demonstration tests UML-2 and UML-4. Key issues brought up by the panel included the need for automation and autonomy in order to achieve UML-4, and that the safety assurance of

automation and autonomy was a key barrier for achieving AAM. The session gathered much interest as evidenced by the 114 participants who joined the virtual event.

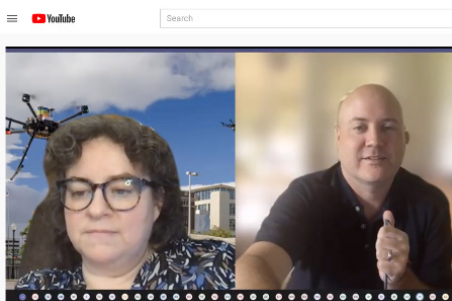
### SWS and Others Contribute Substantially to DASC

POC: [LYNNE MARTIN](#), [TERRY MORRIS](#) AND [MISTY DAVIES](#)

The 39th Digital Avionics Systems Conference (DASC) was held virtually this year from Oct. 11-16 (<https://2020.dasconline.org>). The conference focused on research and reports from the aviation and space domains. NASA contributed to the presentations with 27 papers and assisting in the organization and running of the conference. Sessions were held on verification and validation, safety certification, and design assurance, with a clear focus on small Unmanned Aircraft Systems (sUAS) operations and Urban Air Mobility autonomy and automation. The System-Wide Safety (SWS) project group included team members Terry Morris, Steve Young, Evan Dill, and Ersin Ansel, who all chaired sessions at the conference. Terry Morris assisted with conference organization.

SWS-sponsored research was awarded Best Paper of Session and Best Student Paper with “Adaptive Stress Testing of Trajectory Predictions in Flight Management Systems” by Robert Moss and

Mykel Kochenderfer of Stanford Intelligent Systems; Ritchie Lee of NASA’s Ames Research Center in California; Nicholas Visser and Joachim Hochwarth of GE Aviation; and James Lopez of GE Global Research. The paper was presented in the verification and validation session and reported on a technique called Adaptive Stress Testing, which finds failure events and their likelihoods in flight critical systems. Corey Ippolito from Scalable Traffic Management for Emergency Response Operations (STEReO), an activity within NASA Aeronautics’ Transformation Aeronautics Concepts Program, took part in a panel moderated by Terry Morris to discuss the use of UAS in emergency response operations. Ippolito introduced some of the challenges in emergency response to large events such as wildfires, and described STEReO’s five-pronged approach of advancing UAS Traffic Management (UTM) services, aircraft autonomy, communications, human-system interaction, and domain expertise. Best Paper was awarded to “Human-System Interaction Issues and Proposed Solutions to Promote Successful Maturation of the UTM system” by Cynthia Wolter, Lynne Martin, and Kim Jobe of NASA Ames. The paper was presented in the UAS and Future Concepts session and discussed the takeaway operator-interaction issues observed over five years of Technology Capability Level (TCL) flight demonstrations conducted to



*Cross-Cutting Working Group: Autonomy Panel*

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test the UTM system. The SWS Supplemental Data Service Provider research team was looped into the final two years of this work and may use the TCL-4 data (final year of data collection) in their model testing. Two papers that won Best of Session involved researchers from NASA's Langley Research Center in Virginia in conjunction with other NASA centers, aerospace companies, and academic institutions where the research contained detailed results from the Automation and Information Management Experiments. Best of Session Paper in the Automation Session of the Human Factors Track was awarded to "Evaluation of Onboard System State and Path Awareness Technologies During Transport Operations" by Timothy J. Etherington, Lynda J. Kramer, Renee C. Lake, Thomas Schnell, Randall J. Mumaw, Lance Sherry, Matthew B. Cover, and Tom Evans. Best of Session Paper in the Displays II Session of the Human Factors Track was awarded to "Simulation Study of Technology for Predicted Flight Deck Alerting of Energy" by Timothy J. Etherington, Lynda J. Kramer, Laura Smith-Valazquez, and Maarten Uijt de Haag.

### SWS Participates at International Air Safety Summit Virtual Global Event

POC: [JON HOLBROOK](#) AND [MISTY DAVIES](#)

On Oct. 21, researcher Jon Holbrook of NASA's Langley Research Center



*Invited Speakers, International Air Safety Summit Event*

in Virginia participated as an invited panelist in the International Air Safety Summit Virtual Global Event, sponsored by the Flight Safety Foundation. The goal of the event was to propose new directions for safety risk reductions and exchange information in the areas of safety, training, practical solutions, management, and human factors. Participants in the summit included scheduled airlines, manufacturers and equipment suppliers, trainers, flight crews, maintenance personnel, and industry executives. In his briefing, Holbrook described the focus of his System-Wide Safety project team on systematically collecting and analyzing data on safety-producing behaviors to support development of in-time safety assurance applications.

Appearing on the panel with Holbrook were Martin Plumleigh

of Boeing, James Kwasny and Guy Mouton of American Airlines, and Dieter Reisinger of Austrian Airlines.

### Misty Davies Asked to Participate on Round Table on Autonomous Systems

POC: [MISTY DAVIES](#)

On Nov. 5, Misty Davies, deputy project manager of System-Wide Safety, served as a subject matter expert on a panel titled "A Round Table on Autonomous Systems." This panel was part of the annual System Safety Conference held virtually by the International System Safety Society. The primary question each panelist was asked to address was "what should we do to foster, guide, or otherwise engage to ensure there is a suitably wide and robust path forward to address the system safety

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interests in autonomy?” Davies highlighted NASA’s In-Time Aviation Safety Management System concept and contributed to the broader discussion about the challenges of ensuring safety for increasingly autonomous systems.

### Invited Talk for Guidance & Control Algorithm Verification & Validation

POC: [NATASHA NEOGI](#) AND [CHRISTINE BELCASTRO](#)

Christine Belcastro and Natasha Neogi of NASA’s Langley Research Center in Virginia were invited to give talks at the prestigious Inter-Agency Guidance & Control Algorithm Verification & Validation Seminar Series held Nov. 10. The seminar series is a joint Inter-Agency initiative between the European Space Agency, National Center for Space Studies, German Aerospace Center, French Aerospace Lab, and NASA to exchange experience and information in verification and validation techniques for space guidance, navigation, and controls systems and attitude and orbit control systems. The invitation came courtesy of Cornelius Dennehy, NASA’s capability leadership team lead for guidance and control. The talk summarized research performed under NASA Aeronautics’ Aviation Operations and Safety Program, specifically, follow-on research for the verification and validation of safety-critical aircraft system

technologies developed for loss-of-control prevention and recovery, increasingly autonomous systems, and a broad assurance capability in both current and emerging aviation applications.

### SWS Turns Out for Annual Conference of the PHM Society

POC: [LYNNE MARTIN](#), [PORTIA BANERJEE](#)  
AND [STEVE YOUNG](#)

System-Wide Safety (SWS) researchers of the Diagnostics and Prognostics group and others participated at the Annual Conference of the Prognostics and Health Management Society on Nov. 9-13. The conference brings together a global community of prognostics and health management experts from industry, academia, and government in diverse application areas such as, but not limited to, energy, aerospace, transportation, automotive, smart manufacturing, industry artificial intelligence, and human health and performance. Chetan Kulkarni of NASA’s Ames Research Center in California was the co-chair of the technical committee that overlooks all the technical content for the conference. Held virtually, the conference had a successful turnout with more than 200 registered attendees, 70 papers, and 6 panels ranging from smart communities to space applications. Matteo Corbetta and George Gorospe organized and presented “From Raw Data to

Prognosis: A Hands-on Tutorial.” This tutorial, one of the highlights of the conference, was attended by more than 70 participants. It introduced the audience to a practical implementation of state-of-the-art methods for prognostics by presenting a hands-on example using Python programming language. The exercise was solved by implementing Gaussian process regression (a data-driven approach) to predict the behavior of a time series far ahead in the future. SWS researchers chaired multiple sessions at the conference including the following: Session 1: Monitoring and Diagnostic Methods by Portia Banerjee; Session 2: Prognostics Methods and Algorithms by George Gorospe and Chetan Kulkarni; Session 4: Electric and Autonomous Vehicles by Matteo Corbetta; and Session 6: Deep Learning Methods and Applications by Chetan Kulkarni. Additionally, five papers by SWS researchers were presented at the conference: “Enhancing Fault Isolation for Health Monitoring of Electric Aircraft Propulsion by Embedding Failure Mode and Effect Analysis into Bayesian Networks” by C. Kulkarni et al.; “Risk Assessment of Obstacle Collision for UAVs Under Off-nominal Conditions” by P. Banerjee et al.; “A Decision-Making Framework for Safe Operations of Unmanned Aerial Vehicles in Urban Environments” by C. Kulkarni in collaboration with Vanderbilt

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University; “Modeling Exponential Decay in Maximum Capacitance Across Specified Flight Patterns in Small Aircraft” by C. Kulkarni in collaboration with Pete Rigas from Cornell University; and “Position, Navigation, and Timing Technologies in the 21st Century,” Volumes I and II, Wiley-IEEE Press; 1st ed., Oct. 2020 (Chapter on Commercial UAS by S. Young and E. Dill).

### **SWS Managers Serve as SMEs for Safety Management System Chat**

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

On Dec. 2, System-Wide Safety project manager John Koelling and deputy project manager Misty Davies served as subject matter experts for a virtual panel titled “Safety Management System Coffee Chat.” The panel was part of the annual Business Aviation Convention & Exhibition held by the National Business Aviation Association (NBAA). The NBAA’s Safety Management System (SMS) ad-hoc committee has been working towards guidance and recommendations for business aviation partners who wish to include Unmanned Aircraft Systems (UAS) as part of their business model. The goal of the session was to highlight the benefits and concerns inherent to SMS development for commercial UAS operations.

### **Blue Skies Initiative Executive Committee Conversation and Update**

POC: [PARIMAL KOPARDEKER](#)

On Dec. 7, Parimal Kopardekar of the NASA Aeronautics Research Institute and other members of the Blue Skies Initiative (BSI) executive committee participated on a panel discussing the importance of BSI and what actions have been taken since its introduction last year. A collaborative effort by industry and government, BSI will deliver a future-ready framework for modernizing the National Airspace System that defines a short-, mid-, and long-term vision for aviation. The framework also ensures optimization of resources for all air traffic management stakeholders and users; is economically sustainable and scalable; educates the aviation community, flying public, and new users; and implements new entrant technology without sacrificing security and safety. The session was moderated by Peter Dumont, BSI Working Group Chair and Air Traffic Control Association president. <https://www.atca.org/atca-annual-agenda>

### **Parimal Kopardekar Speaks at Online Unmanned Cargo Aircraft Conference**

POC: [PARIMAL KOPARDEKER](#)

On Dec. 8, Parimal Kopardekar of the NASA Aeronautics

Research Institute gave a talk, “Accommodating Unmanned Cargo Operations in the National Airspace System,” for the Unmanned Cargo Aircraft Conference. The presentation included considerations to safely and efficiently integrate unmanned cargo operations of all sizes into the national airspace system – focusing on specific concepts, technologies, and procedures related to aircraft, network operations centers, and air traffic management, as well as the needs of communications, navigation, and surveillance. The talk addressed interesting considerations within nominal and off-nominal scenarios.

For more program information, visit: <https://unmannedcargoaircraftconference.com>.

### **Misty Davies Featured in FierceElectronics Article**

POC: [MISTY DAVIES](#)

Misty Davies, deputy project manager of System-Wide Safety, was interviewed for the engineering information publication FierceElectronics in a Dec. 15 article titled “As Autonomous Aviation Systems Advance, NASA Seeks to Keep the Skies Safe.” Davies spoke about the future of aviation safety with regard to autonomous aircraft and discussed her role as outreach coordinator, as well as NASA’s roadmap, external collaboration,

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the role of humans in autonomous systems, and autonomous technology safety. Furthermore, she described NASA's plans for ensuring that "as autonomous aviation systems proliferate . . . the commercial airline industry maintains its high level of safety."

### **Misty Davies Moderates Panel on Safety and Security in Autonomous Technology**

POC: [MISTY DAVIES](#)

On Dec. 16, Misty Davies, deputy project manager of System-Wide

Safety, moderated a panel discussion with experts on safety and security in autonomous technology as part of the AutonomousTech Innovation Week. Panelists included Bill Taylor, Managing Director of kVA by UL (formerly Underwriters Laboratories); Steve Povolny, Head of Advanced Threat Research at McAfee; and Phil Magney, Founder and President of VSI Labs. Topics included how makers of autonomous vehicles could know when they have identified all safe and unsafe operating conditions, and a discussion of

possible cybersecurity threats for autonomous vehicles.



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