



AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

APR-JUN 2021 | Quarter 3



NASA ATD-2 Phase 3 Stormy 3
2021 Commences Formal Data
Collection

ATD-2 Reaches More Than One 11
Million Gallons of Fuel Saved at
Charlotte Intl.

AOSP IN THE NEWS

[NASA Articulates Vision for Regional Air Mobility](#)

Aviation Week (4/23) reports: “to succeed, urban air mobility (UAM) requires multiple technological and operational transformations to come together. But through targeted technology investments, regional air mobility can offer early benefits for communities, industry and investors, a new NASA white paper has concluded.”

[NASA Envisions Revived U.S. Regional Air Transportation Network](#)

FlightGlobal (4/26) reports: “the USA’s many small, underused airports, combined with autonomous and electric-propulsion technologies, could enable a vast new US regional air transportation system. That is according to new NASA-published report that lays out a vision called ‘Regional Air Mobility’ – the idea that technology can make air travel between small US airports viable.”

[‘It’s Not Quite Like Riding A Bike’: Pilots Prepare to Fly Again](#)

New York Times (5/07) reports: “one returning pilot lost control of an aircraft during landing and skidded off the runway into a ditch. Another just returning from furlough forgot to activate a critical

anti-icing system designed to prevent hazards in cold weather. Several others flew at the wrong altitudes, which they attributed to distractions and lapses in communication. In all of these incidents, which were recorded on NASA’s Aviation Safety Reporting System, a database of commercial aviation mistakes that are anonymously reported by pilots and other airline crew, the pilots involved blamed the same thing for their mistakes: a lack of practice flying during the pandemic.”

[Springfield Will Be Part of NASA’s ‘Advanced Air Mobility’ Research](#)

Dayton (OH) Daily News (5/17, Gnau) reports: “NASA has chosen a Springfield-based flight research center to help shape the future of passenger travel and cargo delivery, only the strengthening the site’s continue role in such research. FlyOhio, based at the Ohio/Indiana UAS Center and Test Complex in Springfield, received the award, meant to push to reality ‘multiple use cases for personal travel and delivery of goods across the state of Ohio,’ the FlyOhio organization said in a release.”

[NASA Readies For eVTOL Test Flights with Joby Prototype](#)

Aerospace Daily (5/18) reports: “NASA has agreed to work with five

U.S. state and local governments on how to integrate passenger and cargo advanced air mobility into their transportation plans.”

[Drones Flying Near Airports, Infrastructure Prompt U.S. Action](#)

Wall Street Journal (5/20) reports: “the Federal Aviation Administration and the National Aeronautics and Space Administration are developing a joint national air-traffic-control system for low-flying drones.”

[Watch NASA Prepare for Our Flying-Car Future](#)

Mashable (5/26) reports: “instead of taking a bus or train to work, what about a flying car? A Nova TV special, The Great Electric Airplane Race, airing Wednesday night on PBS, explores the possibility of using autonomous, battery-powered flight for commuting or taxi trips. As part of his research into electric flight, reporter Miles O’Brien visited NASA’s Ames Research Center and hopped into its 10-story vertical motion simulator to see what it would be like to fly around San Francisco in one of these vehicles.”

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NASA ATD-2 Phase 3 Stormy 2021 Commences Formal Data Collection

POC: [GREG JURO](#) AND [ERIC CHEVALLEY](#)

NASA's Airspace Technology Demonstration 2 activity entered the Phase 3 formal data collection period entitled "Stormy 21" on April 1. The data collection is scheduled to last four months – until the end of July. Stormy 21 includes real-time operational participation by seven field facilities including American, Envoy, and Southwest airlines, Dallas/Fort Worth Air Traffic Control (ATC) Tower, Dallas

Love Field ATC Tower, Dallas/Fort Worth Terminal Radar Approach Control, and Fort Worth Center. The spring and early summer seasons were selected for the formal testing period due to frequent convective weather resulting in surface delay and reroute opportunities at the North Texas airports. Stormy 21 data collection culminates months of shadow testing, extensive field user training, and thorough assessment of actual Trajectory Options Set (TOS) reroute submissions by flight operators and reroute approvals by ATC. Biweekly reviews of TOS activities and system use with the

field demonstration partners during the past six months led to software enhancements that were deployed to the operational facilities on April 5. The latest software version (6.0) includes agile solutions developed in collaboration with field users to mitigate the impact of ATC staffing constraints caused by COVID-19. Online tutorials and ongoing remote training sessions for field users helped identify operational needs and prepare the users to act upon reroute opportunities. Stormy 21 provides the opportunity to evaluate the system in various weather and traffic

ATD² Recent Example of ATD-2 Phase 3 TOS Digital Reroute

On March 26, 2021, American Airlines 1822 flew Dallas/Fort-Worth (DFW) to Fort Myers (RSW) on a reroute approved using the ATD-2 Phase 3 system.

- American Airlines 1822 was initially filed on the **yellow route**
- ATD-2 projected surface delay due to constraints on the East departure gate
- Based on American TOS preferences, ATD-2 recommended the **blue reroute** out the south gate
- Even though the blue route was 42nm longer, by flying this TOS alternate reroute, American Airlines flight 1822 saved:
 - 16 minutes of surface delay (at takeoff)
 - 20 minutes of surface delay including subsequent departure flights in the American fleet (aggregate system savings)
 - 15 minutes of arrival delay (at the destination's parking gate)
 (AAL1822 was predicted to arrive 19 minutes late on the filed route vs. 4 minutes late on the TOS alternate route)



Example of an ATD-2 Phase 3 TOS Reroute

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conditions, and learn how and when the system is utilized and what benefits could be obtained by using TOS to reroute delayed flights – both from an individual flight and from a system-wide perspective. Lessons learned will be gleaned from data analyses as well as from field users' feedback. These lessons will provide insights into future systems requirements for NASA, the FAA, and the airline industry.

ATM-X Discussion with FAA Technical Center to Identify Collaboration Opportunities

POC: [KURT SWIERINGA](#)

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.

Digital Information Platform Meeting with American Airlines

POC: [MIRNA JOHNSON](#)

The Air Traffic Management – eXploration (ATM-X) project's Digital Information Platform (DIP) team is reaching out to interested parties to establish relationships that will help shape the development of the system concept, and eventually to a successful technology adoption. On April 5, the DIP team met with American Airlines representatives, including from Data Science Analytics, Operations Engineering, and Flight Department, to hold a free-form discussion to better understand stakeholder needs and expectations for a data-driven platform. This was a similar format to the meeting held with Delta Airlines on March 25.

After attending System Wide Information Management (SWIM) Industry FAA Team (SWIFT) #13, where the DIP team first presented the concept, the team followed up for feedback on the concept and captured the measurable benefits it could bring. This is expected to be one of many sessions to dive deeper into the data and service needs of the stakeholder community.

ATM-X Attends Kickoff Meeting for ASTM Working Group

POC: [KURT SWIERINGA](#)

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.

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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.

ATM-X, UAM, and NC-DT Complete Final Report on X3 Simulations

POC: [SAVVY VERMA](#) AND [JOHN SPRAGUE](#)

Between May and December of 2020, the Air Traffic Management – eXploration (ATM-X) project’s Urban Air Mobility (UAM) subproject designed and conducted X3 simulations with the National Campaign’s Developmental Test (NC-DT) airspace partners in collaboration with the NC’s Airspace Test Infrastructure team, who provided data collection capabilities. Out of the 11 NC-DT airspace partners, nine participated in at least one data collection activity. The data analyses for the X3 simulations were completed and individual data was provided to participants (industry partners) in February 2021. On April 7, a final report co-authored by the UAM and NC subprojects, describing the tests, scenarios, airspace, and results, along with insights gained regarding UAM operations, was completed as a NASA

Technical Memorandum. This was distributed to all the partners who participated in the X3 simulations, marking the completion of the milestone outlined in the agreement with the industry partners.

V&V Vision 2045 NASA Research Announcement Awardee Selection Advances Assurance of Autonomy Development

POC: [MISTY DAVIES](#)

AOSP’s System-Wide Safety project and the Transformative Aeronautics Concepts Program put out a joint call for external stakeholders to define a research roadmap for the verification and validation (V&V) and assurance of autonomy through the year 2045. The V&V Vision 2045 NASA Research Announcement solicited a number of excellent submissions, and NASA has selected an awardee. Boeing Research and Technology, together with General Electric Aviation, Collins Aerospace, the University of Michigan, Massachusetts Institute of Technology, and the University of Texas at Austin, will collaborate over a one-year period of performance. This roadmap will consider both near-term needs together with industry and standards consensus bodies, as well as long-term needs for achieving the advanced Urban Air Mobility maturity levels. Additionally, the roadmap will

be used to guide NASA, as well as other national stakeholders, in strategic research investment decisions. The kickoff for the NASA Research Announcement is anticipated to be in May 2021.

SWS Demonstrates Extension of the Dashboard Using Relevant Case Study (Taxinet)

POC: [GUILLAUME BRAT](#)

Researchers from the System-Wide Safety project have completed work demonstrating the extension of the dashboard using a relevant case study (Taxinet – an autonomy testbed platform supplied by Boeing) by performing a live demonstration to project management and other subproject managers. The Safety Management System (SMS) concept is a proactive approach to system safety, intended to provide a structured means of safety-related decision making. The goal is to identify and manage safety risks well before system failures and loss events occur, while increasing confidence that risk controls in place are performing as intended. SMS is central to the FAA’s approach to achieving acceptable levels of safety risk for both aircraft systems and airspace/air traffic management systems. Two central pillars of the FAA’s SMS approach are Safety Risk Management and Safety Assurance. Safety Risk Management is meant to identify and assess risk and develop

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risk mitigation controls; Safety Assurance involves monitoring and tracking the performance of the risk mitigation controls defined during Safety Research Management. The team demonstrated a preliminary integration of risk-based design, development, and assurance in the Assurance Case Automation Toolset. Specifically, the team is allowing trade trees that record decision alternatives such as design decisions to be presented – outlining the impact of each alternative on baseline risk levels and existing assurance artifacts, decisions about those alternatives to be made and recorded, and justifications of those decisions to be provided as assurance arguments. Thus, integrating decision-making, assurance impact analysis, and safety assurance case development within a common framework is achieved. The team also illustrated the approach on the Taxinet system and demonstrated that upon a risk materializing, they can enumerate design alternatives showing how risk-informed decision making is used to select a feasible design alternative while also updating the associated assurance case.

SWS Demonstrates Expansion & Application of Uncertainty Representation Framework

POC: [STEVE YOUNG](#) AND [WENDY OKOLO](#)

Researchers from the System-Wide Safety (SWS) project have completed work to expand

the uncertainty management framework described in NASA TM-220440 (January 2020) which was associated with an SWS annual performance indicator. Evaluation of the expanded framework was completed for safety-related services, functions, and capabilities (SFCs) under development within the project. This framework for uncertainty representation, handling, and management was designed to accommodate different sources of uncertainty (associated with inputs, models, measurements, and computing methods) in the computation of the SFC outputs and metrics. By identifying the sources of uncertainty and how they propagate or manifest during flight operations, safety assurance assumptions can be validated and appropriate margins can be defined. The report also gives an overview of the groundwork laid to compute SFC outputs/metrics for which the uncertainty representation framework was tested and evaluated. Work on expanding and applying the framework was conducted at both NASA's Ames Research Center in California and NASA's Langley Research Center in Virginia. At NASA Ames, the focus was on wind uncertainty, positioning system errors, and uncertainties associated with unmanned aerial vehicle electric powertrains. At NASA Langley, the focus was on uncertainties associated with non-participant casualty risk assessment.

Space Act Agreement Annex Executed Between SWS Project and Boeing

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

On April 19, a Space Act Agreement annex was executed between NASA's System-Wide Safety (SWS) project and Boeing for the "integration, demonstration, and evaluation of autonomous systems and tools." The agreement signed is Annex 16 under the Space Act Agreement umbrella SAA1-23831. The annex will enable the application and integration of formal methods based analysis, verification, testing, and monitoring tools in the design-time and operation-time assurance processes of autonomous systems. The collaborative effort has the objective to demonstrate the capability of these tools to determine the quality and safety improvement in the development life cycle of autonomous systems. The agreement supports development of solutions and helps inform NASA participation in artificial intelligence (AI) standardization (e.g. SAE G-34/EUROCAE WG-114) in aviation standards, to identify safety challenges and gaps, and to establish standards in the use of tools developed with this collaboration. The partnership with Boeing continues the exploration of autonomy and AI requirements, assurance approaches, evaluation methods, and means of compliance

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that support AI standardization and explore paths to certification.

SWS Participates in 2021 Boeing IRAD Review

POC: [NATASHA NEOGI](#)

The Boeing Independent Research and Development (IRAD) review took place for three hours per week between March 9 and April 22. Many subject matter experts (SMEs) external to Boeing were invited to review the work of cutting-edge Boeing researchers across many technical topics. Researcher Natasha Neogi of NASA's Langley Research Center in Virginia was invited to participate as an SME reviewer for the autonomous systems subtopic, and there was considerable discussion related to work being done on verification, validation, and certification in the context of unmanned aerial vehicles that were directly related to NASA's System-Wide Safety project interests. Neogi also served as a reviewer for research on guidance, navigation, and control as well as work on precision, navigation, and timing. She was able to exchange opinions with other expert reviewers from government, including the Air Force Research Laboratory, Department of Energy, and academia including MIT and Georgia Tech, and helped synthesize broad consensus reviewer-response documentation. This was the first ever virtual instantiation of the event held online via WebEx.

SWS HC2S Research Presented to Boeing Training and Flight Deck Technical Groups

POC: [CHAD STEPHENS](#)

On April 22 and 28, Chad Stephens of the System-Wide Safety (SWS) project presented invited talks to more than 100 attendees on joint NASA-Boeing research in Human Contributions to Safety (HC2S) to the Boeing Global Services (BGS) Standards and Training group and the Boeing Commercial Airplanes (BCA) Future Flight Deck technical group, and on a recent human-in-the-loop flight simulation study conducted in collaboration with Boeing researchers under an existing non-reimbursable Space Act Agreement at the Boeing Commercial Flight Training Campus in Miami. The focus of the research study was collecting and analyzing data on how commercial aviation flight crews handle routine disturbances, both expected and unexpected, in commercial flight operations to explore HC2S. The presentations described the collaborative study involving three commercial aviation flight crews performing four area navigation standard terminal arrival route (RNAV STAR) arrivals into Charlotte Douglas International Airport in the Boeing 737 NextGen full flight simulator. The objective of the 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 BGS Standards and Training group's interests in the SWS HC2S research are focused on identifying and enabling resilient performance as evidenced and supported by competency-based training methods. The BCA Future Flight Deck technical group's interests in the SWS HC2S research are focused on critical considerations for designers and developers of advanced commercial transport systems. The recent human-in-the-loop simulation study was conducted in collaboration with researchers from Boeing's Research and Technology group (Beth Biddle and Jack Dwyer) and from Boeing's Standards and Training group (Jim Wilkerson). Follow-up actions from the meetings included discussing collaborations as future internal projects are planned, as well as providing publications describing SWS HC2S research.

ATM-X/UAM Subproject Presentation at MIT Lincoln Laboratory ATC Workshop

POC: [IAN LEVITT](#)

On April 27 and 28, Ian Levitt, principal engineer for the Air Traffic Management – eXploration (ATM-X) Urban Air Mobility (UAM) subproject, presented at the MIT Lincoln Laboratory Air

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Traffic Control Workshop. Levitt kicked off the session on Advanced Air Mobility (AAM) and UAM with a briefing covering the UAM airspace concept and the subproject's plans for researching UAM's airspace architecture with the X4 simulation. Joby Aviation followed, providing an industry perspective on UAM, and MIT Lincoln Laboratory presented on operational simulation capabilities that they are developing. The panelists then transitioned to a lively Q&A session, touching on topics such as weather, demand modeling, noise impacts, applications of artificial intelligence and machine learning, and regulatory paths to operationalization. The exchange was a good opportunity to showcase the breadth of NASA's research portfolio in the area of AAM and their approach to collaboration with industry.

SWS Presents to the Autonomous Defense Systems T&E Working Group

POC: [GUILLAUME BRAT](#)

System-Wide Safety (SWS) researcher Guillaume Brat presented the research being conducted by the Robust Software Engineering (RSE) group on software and system assurance for autonomy to the Autonomous Defense Systems (ADS) Test & Evaluation (T&E) working group on April 28. For the past 10 years, Brat and his group have been developing tools and

techniques for software assurance in aviation systems under the SWS project. The tools cover all phases of the development process, from requirements to coding and then testing. RSE researchers have worked closely with industry to develop open source tools that can make a difference on real systems. The research first targeted traditional aviation systems such as transport aircraft. For the past two years, however, the focus has shifted to increasingly autonomous aviation systems that will be used for the Advanced Air Mobility market (e.g. autonomous package delivery or autonomous air taxis) and for disaster response (e.g. unmanned aerial vehicles for wildfire management). As part of his presentation, Brat presented the strategy adopted to build these tools and what implications it has on a potentially new certification process for machine-learning enabled systems. The ADS T&E working group aims at developing a guidebook for the T&E of autonomous systems. The guidebook is being developed by the Scientific Test and Analysis Techniques Center of Excellence as guidance for test planners and test engineers for ADS. The group consists of representatives of the various armed forces including the Coast Guard and has drawn interest from the Earth science community, especially for disaster response and wildfire management.

The systems being targeted rely on artificial intelligence, in particular, machine learning. Brat was asked by the working group leadership to present an overview of the tools (FRET—requirement elicitation and analysis, CoCoSim—verifying Simulink models, IKOS—static code analysis, AdaStress—adaptive stress testing, MARGInS—identifying safe operational boundaries through statistical testing, R2U2—runtime monitoring, and Prophecy—analyzing neural networks) and what impact they will have on certification of increasingly autonomous systems.

SWS Delivers Capability that Extends NASA's Precursor Analysis Scope

POC: [NIKUNJ OZA](#)

The System-Wide Safety (SWS) project has recently completed work delivering an initial capability that extends NASA's previous precursor analysis to risk over multiple adverse events. SWS's Technical Challenge 1: Integrated Terminal Area Risk (milestone TC1-02-03) recently completed work developing a new algorithm that accepts, as input, a dataset of flights that have various adverse events within them and identifies precursors to these adverse events, including the features that describe these precursors and the times at which they occur. This work was completed on May 1.

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NASA Aeronautics Cybersecurity Workshop

POC: [PAUL NELSON](#)

On May 4, an ARMD Cybersecurity Workshop was virtually conducted by System-Wide Safety researcher Paul Nelson of NASA's Glenn Research Center in Cleveland. This workshop was the first in a series of workshops presenting important cybersecurity topics of critical interest to ARMD research. The series began with an overview of ARMD's cybersecurity efforts, the ARMD cybersecurity team capabilities, and the direction of aviation cybersecurity. The value of incorporating cybersecurity engineering early in a project's lifecycle was discussed. A question and discussion period was held following the presentation. A repeat of this workshop was held on May 13.

NASA/FAA Quarterly Review

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

On May 10, the Air Traffic Management – eXploration (ATM-X) project met with stakeholders to exchange information at the NASA/FAA quarterly review. FAA participants included Diana Liang, Enterprise Portfolio manager; Nabil Sandhu, Advanced Air Mobility Below Visual Line of Sight National Airspace System Evaluation (BNE) lead; Sherri Magyarits, Upper Class E Traffic Management (ETM) Concept of Operations (ConOps)

lead and Research Transition Team co-lead; and Nouri Ghazavi, Urban Air Mobility ConOps lead. The FAA presented updates on their National Airspace System 2035 vision, BNE research, and UAM ConOps. ATM-X presented research status and schedule updates for the “Sky for All” concept development, Pathfinding for Airspace with Autonomous Vehicles (PAAV), Extensible Traffic Management (xTM), ETM, and UAM Airspace Management. Sky for All was presented by Shawn Engelland, who provided status updates on future schedules, as well as an update on the final version of the Sky for All video displayed at the NASA virtual booth at the Air Traffic Control Association Technical Symposium held from May 17-21. PAAV was presented by Robert Fong and Tod Lewis who updated the group on PAAV's status and the LMI market study findings, as well as future collaboration opportunities with the FAA. Jaewoo Jung presented ETM research transition team updates and followed up with a NASA/FAA open discussion regarding collaboration on the Digital Mesh Technology Application (DMTA) RTT xTM – ATC working group. UAM subproject manager Kevin Witzberger presented the partnership status on Joby Aviation (formerly Uber Elevate) as well as the overview and timeline for the National Campaign (NC-1) Simulation Effort X4.

Preliminary UAM Airspace Roadmap Shared with Key FAA Personnel

POC: [KEVIN WITZBERGER](#)

The UAM subproject management team met with representatives from the NASA Aeronautics Research Institute (NARI) and representatives from the FAA's AJV (Mission Support), ANG (NextGen), and ATO (Air Traffic) united to discuss NASA's preliminary version of the Urban Air Mobility (UAM) Airspace Roadmap. This roadmap is tailored for the FAA to facilitate an efficient review and comment cycle and is the first of three near-term UAM Airspace Roadmap artifacts that are currently in progress. The UAM Airspace Roadmap summarizes how NASA's UAM airspace research is expanding on the existing UAM Maturity Level (UML) framework to establish a system engineering artifact that will document assumptions, requirements, constraints, and system architectures during the lifecycle of NASA's UAM airspace research and development. The UML scale is a useful framework for understanding and evaluating the evolution of the National Airspace System as it pertains to UAM, where the UMLs themselves are the periods of change that build up to significant “step-functions” in operational capabilities. While the existing UML definitions provide

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an extensive and well-defined treatment of the progression of UAM from a vehicle operations perspective, they are limited in their treatment of the airspace component. The UAM Airspace Roadmap is expected to start identifying the airspace progression necessary to evolve the airspace towards UML-4. After updating the roadmap from feedback received from key FAA representatives, NASA intends to share it with Advanced Air Mobility's Mission Integration Office and executive board working group later in May.

xTM Subproject Joins FAA for UPP Phase 2 Briefing Effort to CTIA

POC: [JAEWOO JUNG](#)

On May 12, the Air Traffic Management – eXploration (ATM-X) project's Extensible Traffic Management (xTM) subproject manager, Jaewoo Jung, joined the FAA for a briefing on the status of the Unmanned Aircraft Systems (UAS) Traffic Management (UTM) Pilot Program (UPP) Phase 2 effort to CTIA (formerly Cellular Telecommunications and Internet Association), a trade association representing the wireless communications industry in the United States. UPP is an important component of the FAA's UTM implementation process. NASA, FAA, and industry partners successfully completed UPP Phase

1 in Summer 2019, demonstrating an information-sharing network for UAS operating below 400 feet. UPP Phase 2 flight activities were completed in Autumn 2020 and included a demonstration of the FAA Flight Information Management System prototype and infrastructure, new technologies and data to validate the latest ASTM (formerly American Society for Testing and Materials) standards for remote identification and UAS service supplier interoperability, and UAS volume reservations to notify drone operators of emergencies and to ensure other UTM capabilities are integrated appropriately. UPP Phase 2 also evaluated secure information exchanges between the FAA, industry, and authorized users for ensuring data integrity. The CTIA audience appreciated the briefing, commending the dedication and creativity of the UPP Phase 2 team for safely overcoming the COVID-19 challenges while preparing and conducting field tests. Answers to questions about test details, such as cybersecurity arrangement and operational density, were provided by the FAA and NASA briefers. The UPP effort was initially supported by NASA's UTM project, and transitioned to the ATM-X project with the closing of the UTM project. The ATM-X project is continuing cooperation with the FAA and industry for a potential follow-on UPP event.

Diagnostics & Prognostics Group Releases New Prognostics Research Python Packages

POC: [WENDY OKOLO](#) AND [CHRIS TEUBERT](#)

System-Wide Safety project researchers from the Diagnostics and Prognostics Group and the Prognostics Center of Excellence (PCoE) at NASA's Ames Research Center in California have released a pair of Python packages to assist in prognostics research. These packages provide modular, extendable tools for creating and simulating degradation (prognostics) models, performing systems health-state estimation and prediction, creating new systems health-state estimation and prediction algorithms, benchmarking prognostics performance, and visualizing results. These tools are intended to help researchers in industry, academia, and government build new models, algorithms, and software architectures for prognostics. Functionality is similar to the previously released MATLAB [Prognostics Model](#), [Algorithm](#), and [Metrics Libraries](#), but these tools are written in Python, responding to a trend towards Python in the Prognostics and Health Management community, and apply the lessons learned since the creation of the MATLAB libraries. There are two parts to the PCoE's Python prognostics packages: prognostics models and prognostics algorithms.

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The team members are Matteo Corbetta, Chetan Kulkarni, and Chris Teubert.

Focus Meeting for the Data Analysis and Prediction RTT Effort Fosters Interest

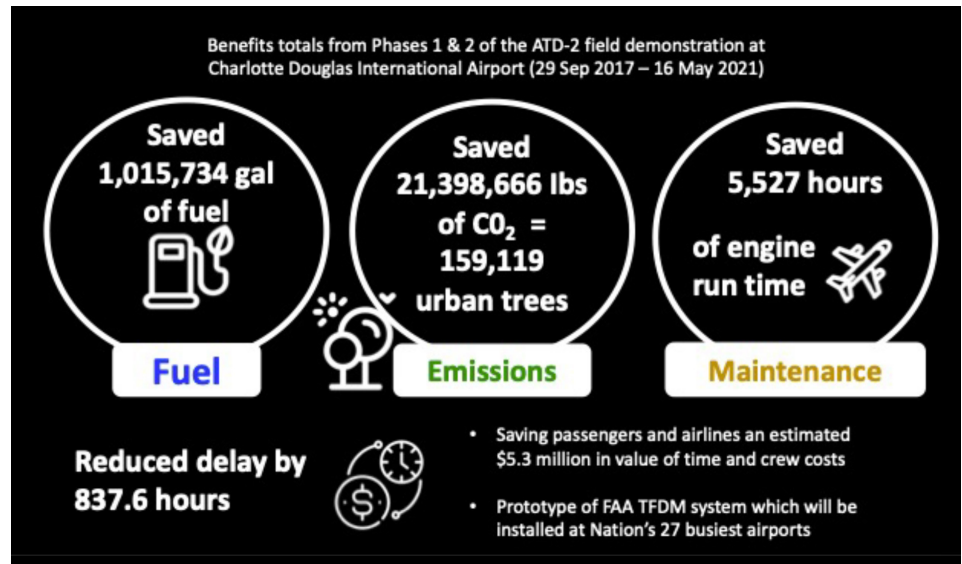
POC: [NIKUNJ OZA](#)

On May 13, a focus meeting for the Data Analysis and Prediction Research Transition Team (RTT) effort was led by Nikunj Oza. The meeting fostered interest between NASA and FAA personnel on connecting with Testbed and discovering where machine learning is relevant. At the previous quarterly meeting, a breakout session led by Kee Palopo discussed the Air Traffic Management – eXploration Testbed and facilitated a desire for more focused discussion that was provided at this monthly focus meeting.

ATD-2 Reaches More Than One Million Gallons of Fuel Saved at Charlotte Intl.

POC: [DIVYA BHADORIA](#)

As of May 16, NASA's Airspace Technology Demonstration 2 (ATD-2) subproject, in collaboration with American Airlines and FAA Air Traffic Control facilities, has saved flight operators more than one million gallons of jet fuel since September 2017 during the Phase 1 and 2 field demonstrations at Charlotte Douglas International Airport. These savings resulted



Summary of ATD-2 Benefits up to May 16, 2021

from ATD-2 Integrated Arrival, Departure, and Surface (IADS) system-recommended actions, such as holding departures at gates with engines off, surface metering during peak periods, pre-scheduling the departure approval request (APREQ) flights at gates, and renegotiating the release times of APREQ flights while taxiing through electronic coordination between ATD-2's IADS system and the FAA's Time Based Flow Management/Integrated Departure Arrival Capability, which eliminates verbal communications between Charlotte Tower and Air Route Traffic Control Centers. In addition to the fuel savings, the ATD 2 IADS system has reduced CO₂ emissions by 21.4 million pounds, which is equivalent to planting more than 159,000 urban trees

based on [formulae developed by the US Environmental Protection Agency \(EPA\)](#). Flight operators at Charlotte also saved 5,527 hours of engine run time, and more than one million dollars in crew cost. The detailed calculations and additional operational benefits are described in the figure below.

NASA/AOSP Play Active Role at ATCA Technical Symposium

POC: [BARRY SULLIVAN](#)

Several NASA speakers participated at the Air Traffic Control Association (ATCA) Technical Symposium from May 17-21. Each year ATCA, alongside technical co-chairs NASA and the FAA, holds its premier technical conference in which hundreds of people come together to focus on

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the latest ideas, research, products, and services in the air traffic control arena. During the technical symposium, attendees learn more about federal involvement, including exciting research and development conducted at the FAA William J. Hughes Technical Center and at NASA. Additionally, attendees hear industry and government leaders speak on new entrants and non-traditional airspace users, artificial intelligence/augmented reality, machine learning, automation, aviation safety, and much more; they also see the latest in air traffic control and air traffic management research, products, and services. Attendees include representatives from government, industry, academia, and other aviation stakeholders. This year NASA speakers included Bob Pearce, associate administrator of ARMD, who participated in a discussion with Pamela Whitley, associate administrator for the FAA's NextGen, on a fireside chat "Charting Aviation's Future." Akbar Sultan, director of AOSP, participated in the opening remarks giving an overview of ARMD's research portfolio and relevant research capabilities/facilities. Cheryl Quinn, deputy director of AOSP, participated as a speaker on "The Digital Transformation of Our ATM System" panel. Misty Davies, System-Wide Safety project manager, was a speaker on the "Intelligent Airspace with AI: From

Bots to Safety Critical Aviation Operations" panel. Al Capps of the Airspace Technology Demonstration 2 subproject was a speaker on the "R&D: Paving the Way to a More Sustainable, Resilient NAS" panel. Parimal Kopardekar of the NASA Aeronautics Research Institute participated in a roundtable discussion. Barry Sullivan integration manager of AOSP, was a speaker on the "ATCA Technical Symposium Buzz Session."

In addition, AOSP held virtual booths highlighting the program's research portfolio and technical achievements. This year's event had more than 400 attendees who participated in the week-long virtual event. For more information see the following website: <https://www.atca.org/techsymposium>

ATM-X PAAV Meets with FAA ANG-E

POC: [ROB FONG](#)

On May 25, the Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject met with the FAA William J. Hughes Technical Center (FAATC) Office team (ANG-E) to explore potential collaborations between NASA's Air Traffic Management – eXploration (ATM-X) project and the FAATC to accelerate research and development to address critical barriers to enable routine unmanned aircraft cargo operations. During the meeting,

PAAV discussed its approach, which included development of a concept of operations for unmanned aircraft cargo operations, planned research, partnership strategy, and flight demonstration plans. A follow-on meeting is planned for June 8 to continue discussions of potential collaborative efforts between the FAATC and ATM-X.

SWS Project Manager Leads AAM Ecosystem Cross-Cutting Working Group Assurance of Autonomy Panel

POC: [MISTY DAVIES](#)

System-Wide Safety project manager Misty Davies led a panel for the Advanced Air Mobility project's Ecosystem Cross Cutting working group Assurance of Autonomy virtual session on May 25. Approximately 135 attendees participated. Panelists for that session included George Romanski, FAA chief scientific and technical advisor for aircraft computer software; Jim Paunicka, a technical fellow for autonomy with Boeing Research and Technology; Eric Wright, the head of certification and test at Archer; and Suresh Kannan, an autonomy expert at Nodein. Primary topics included the European Union Aviation Safety Agency's new guidance for the assurance of machine learning/artificial intelligence, drivers for the use of autonomy, and a few highlighted barriers and challenges.

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NASA Presents Much-Appreciated ASRS Capability to the UAST

POC: [BECKY HOOEY](#) AND [STEVE YOUNG](#)

Based on recommendations by the industry-based Unmanned Aircraft Safety Team (UAST), System-Wide Safety has been working with the FAA to enhance NASA's Aviation Safety Reporting System (ASRS) to enable better reporting of Unmanned Aircraft System (UAS) incidents as well as better analysis of reports regarding safety-relevant trends and precursors in this domain. In April, two important milestones were achieved toward this goal. First, on April 2, a revised FAA Advisory Circular (AC 00-46) on ASRS was published. This new advisory circular provides, among other things, protections from punitive action to those in the UAS domain who submit reports to the system regarding safety-related events or occurrences. This new and extensive group of individuals goes well beyond those who traditionally have reported events to ASRS (e.g. airline pilots and air traffic controllers). Secondly, on April 14, a UAS-specific form was published as part of the ASRS. This allows anyone who submits a report to use a tailored form that utilizes vernacular more commonly known to individuals involved in flights in the UAS domain. This form was developed in conjunction with UAST members (both

industry and government) and Becky Hooey's ASRS team. With this capability now on-line, and the associated FAA policy in place, the resulting reports should provide a wealth of new insights, analysis, and risk mitigation research to be undertaken regarding real-world UAS hazards, incidents, accidents, and contributing factors. At a follow-on meeting on May 26, Becky Hooey presented the new ASRS capability. NASA and Hooey received kudos and appreciation from the chairs during the meeting. The UAST sees this new ASRS capability as much needed and is looking forward to learning from the reports that will be generated because of the new capability.

DIP Receives Request For Information Responses

POC: [MIRNA JOHNSON](#)

The Air Traffic Management – eXploration (ATM-X) project's Digital Information Platform (DIP) subproject released a request for information (RFI) on March 14 to obtain information defining collaboration strategy and identify community needs and goals. As a follow-on activity, DIP hosted an online information session on April 14 that provided the stakeholder community with background on DIP, example use cases, collaboration approach, and areas of potential contributions both from NASA and interested

parties. There were approximately 120 external participants who engaged in a Q&A session after the presentation. The purpose of this information session was to help the community understand the scope of DIP and thus respond to the RFI in a meaningful way. In late May, the RFI received more than 40 responses from various communities which included six flight operators, 18 service providers, 12 data integrators, and six cloud and infrastructure providers. Although DIP has a near-term objective to prioritize traditional operations, DIP must be positioned to support and scale to emerging operations as well. By receiving at least eight respondents with direct interest in emerging operations, DIP will be engaging with a diverse and broad community to shape the concept and demonstrations.

NASA Langley Hosts 13th Annual NASA Formal Methods Symposium

POC: [AARON DUTLE](#)

The 13th Annual NASA Formal Methods Symposium (NFM 2021) took place virtually from May 24–28. More than 150 people from industry, academia, and government participated in the event. Formal Methods researchers and practitioners from institutions such as the FAA, ONERA (French Aeronautics, Space, and Defense Research Lab), NASA,

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and universities around the planet contributed to the program. More information can be found at the NFM 2021 website, <https://shemesh.larc.nasa.gov/nfm2021/>, including links to recordings of all the talks and keynote addresses. The program included 24 research papers, five internationally renowned keynote speakers, and an affiliated workshop (F IDE 2021). The NASA Formal Methods team, including many members from the National Institute of Aerospace, organized the event, which was sponsored and funded by the System-Wide Safety project, with technical support provided by the NASA Aeronautics Research Institute.

SWS Project Team Introduces New Framework for Accommodating Uncertainty

POC: [WENDY OKOLO](#) AND [STEVE YOUNG](#)

The System-Wide Safety project team has created and demonstrated a framework for uncertainty representation, handling, and management (TC2-03-08). This framework, explained in a paper published March 29, 2021, "[An Approach For Uncertainty Quantification And Management of Unmanned Aerial Vehicle Health](#)," and authored by Matteo Corbetta, Chetan Kilkarni, Portia Banerjee, and Elinirina Robinson is designed to accommodate different sources of uncertainty (such as the inputs, models, measurements, and computing methods) in the

computation of In-Time Aviation Safety Management System (IASMS) service outputs and metrics. This research proves uncertainty can be reasonably quantified in order to lessen threats pertaining to or originating from autonomous systems in the National Airspace System. The framework is still evolving as more scenarios are discovered and will be completely implemented in the future to support the IASMS.

NASA Renews Space Act Agreement with GE for Safety Assurance of Flight Critical Systems

POC: [GUILLAUME BRAT](#)

NASA has just renewed its Space Act Agreement (SAA) with General Electric (GE) to collaborate on software assurance for increasingly autonomous systems. The umbrella agreement is for five years, lasting through May 2026. The first three-year annex focuses on safety assurance research to broaden knowledge of operational risk assessment, evidence curation, and adaptive stress testing. The previous SAA between NASA and GE Global Research expired on May 24. This agreement has increased the collaboration between NASA and GE. Some of the activities and accomplishments under this SAA included: (1) regular monthly meetings to review research needs and possible solutions; (2) successful

technology transfer of a NASA-developed adaptive stress testing tool (AdaStress) to GE Aviation; (3) technology transfer of AdvoCATE, a NASA-developed tool to create and review safety cases; and (4) review of the Formal Requirements Elicitation Tool (FRET), a NASA-developed tool to elicit and formalize requirements for critical systems. The new agreement with GE enables NASA to work with all GE business units and builds on the past collaboration by applying, for example, the AdaStress tool to a flight management system and helping GE incorporate it into their production testing environment.

SWS and Agility Prime Discuss Firefighting Use Case Collaboration

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

On June 2, the System-Wide Safety (SWS) project held a technical integration meeting with Agility Prime's leadership to discuss possible collaboration points for Agility Prime's Firefighting Use Case and SWS's Safety Demonstrator Series. Joey Mercer presented the impact of NASA's Scalable Traffic Management for Emergency Response Operations (STEReO) activity under the Transformative Aeronautics Concepts Program's Convergent Aeronautics Solutions project, and Natasha Neogi presented the current plans for SWS and how the Safety Demonstrator Series will leverage

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STEReO. Previous technical interchange meetings focused on Agility Prime's plans and SWS's In-Time Aviation Safety Management System. These meetings are in preparation for the upcoming Space Act Agreement between NASA and Agility Prime being led by the Advanced Air Mobility Mission Integration Office.

SWS Presents on Safety Issues of Integrating Cargo-Carrying UAS into the NAS

POC: [NATASHA NEOGI](#)

On June 4, Natasha Neogi presented a briefing at the Air Traffic Management – eXploration (ATM-X) project's Pathfinding for Airspace with Autonomous Vehicles Concept of Operations Workshop on a safety perspective on integrating cargo-carrying Unmanned Aircraft Systems (UAS) into the National Airspace System. Entitled "Towards Automitigation: A Safety Perspective," Neogi's presentation highlighted certification challenges for UAS as well as issues related to operational approvals that these systems would need to receive in order to gain access to the airspace system. Non-traditional methodologies for tackling hazard analyses of novel concept of operations for new vehicle systems were discussed, specifically the system theoretic process analysis. Additionally, an algorithm for automatically performing

contingency management maneuvers was outlined.

NASA Research Announcement Kickoff Meeting Held for SWS Work with Notre Dame and Iowa State

POC: [LILLY SPIRKOVSKA](#)

On June 7, a kickoff meeting was held to share and review plans for a new cooperative research agreement between the System-Wide Safety (SWS) project and a team from the University of Notre Dame and Iowa State University. The three-year agreement is a result of a NASA Research Announcement solicitation. The number of small Unmanned Aircraft Systems (sUAS) have risen dramatically in recent years, resulting in numerous reported incidents involving near collisions in controlled airspace or out of control sUAS in populated areas. This creates the risk of serious accidents. The problem is exacerbated by the diverse quality and robustness of sUAS and also by the varied skills of their operators. This research activity focuses on: (1) developing a diverse dataset of annotated sUAS flight logs collected from internal flights and crowd-sourced from other FAA part 107 certificated remote pilots, as well as hobbyist pilots; (2) developing techniques for detecting and interpreting anomalous flight patterns; (3) finding runaway emergent behavior due to interactions between hardware,

software, and environmental conditions; and (4) analyzing underlying causes of flight anomalies to identify appropriate mitigations. The planned work directly benefits ongoing research in the SWS project. The team anticipates mutual leveraging of cooperative efforts, utilizing their analytics and insights as part of NASA's monitor-assess-mitigate strategy and in deploying SWS's services, functions and capabilities on their sUAS.

NASA-Joby Urban Air Mobility Use Case Discussion with the FAA

POC: [SAVVY VERMA](#)

On June 10, the Air Traffic Management – Exploration (ATM-X) project's Urban Air Mobility (UAM) subproject conducted their first of four planned meetings with the FAA and industry partner Joby Aviation to create a set of use cases in the Dallas area that were presented and discussed with FAA stakeholders. This series of meetings will help to refine airspace and procedure concepts for UAM operations in the near term. FAA participants included representatives from the FAA's NextGen, Air Traffic Organization, and Air Traffic Services organizations. This activity is seeking direct input from airspace experts in the form of group discussions focused on a series of UAM scenarios or use cases that range from

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operations flying in Class E or G airspace that require no or minimal interaction with air traffic controllers to operations inside controlled airspace. The usage of current day tools like letters of agreements to achieve UAM operations were also explored. The use cases/scenarios will cover a range of operational challenges and potential solutions. The results and lessons learned from these sessions will be used to identify research questions and upcoming simulation studies planned for the UAM subproject.

ATM-X xTM/ETM Continue Presenting Upper Class E Research Plans to Stakeholders

POC: [WILLIAM CHAN](#) AND [JAEWOO JUNG](#)

This past quarter, the Extensible Traffic Management (xTM) subproject of the Air Traffic Management – eXploration (ATM-X) project provided several detailed briefings of its Upper Class E Traffic Management (ETM) research to their various stakeholders. On April 7, the ETM work was presented to the Association for Unmanned Vehicle Systems International. The presentation was a result of a previous presentation to the Aerospace Industries Association on March 17. William Chan provided an overview of the ATM-X project to set the context, while

Jaewoo Jung presented the ETM information specific to the xTM subproject. Jung discussed the challenges of operating in Upper Class E airspace, reviewed the work that has been done in previous FAA and industry tabletop meetings, and xTM subproject work to define a service-based cooperative approach to ETM.

On April 30, the team met with the assistant director of the Montana Space Grant Consortium (MTSGC), an affiliate of NASA's National Space Grant College and Fellowship project. In 2017, MTSGC led a nationwide eclipse ballooning campaign during the total solar eclipse (website: <https://eclipse.montana.edu/>). In this campaign, students conducted balloon flights in the Upper Class E airspace from more than 25 locations across the eclipse path from Oregon to South Carolina, and live videos and images from the near-spaceflights were submitted for display on the NASA website. Proposals are being submitted to conduct a similar campaign during the 2023 annular and 2024 total solar eclipses. The ETM team and MTSGC discussed potential opportunities for collaboration and agreed to meet again to discuss details of more specific areas for collaboration and appropriate agreement processes that can be leveraged.

On June 10, the ETM team

met with representatives from industry and the FAA. In this meeting, a Department of Defense representative briefed on how the U.S. Navy currently coordinates high-altitude operations for munitions testing with the FAA, and MTSGC representatives presented stratosphere balloon operations for the 2017 solar eclipse and their coordination with FAA centers. NASA and the FAA provided a review of the Unmanned Aircraft Systems Traffic Management system and discussed how its requirements, architecture, and data exchange process could be leveraged for the ETM system development. The meeting concluded with an update on NASA's ETM simulation work and the attendees were invited to the upcoming ETM workshop, scheduled for July 21-22, to discuss and further develop ETM concepts.

DIP Meets with America for Airlines and Delta to Discuss RFI Evaluation Status

POC: [MIRNA JOHNSON](#)

On June 10, NASA's Digital Information Platform (DIP) team met with Andy Cebula, vice president of America for Airlines, and Robert Goldman, senior manager of air traffic management at Delta Airlines, to discuss next steps following the request for information (RFI) evaluation. NASA is looking to engage with

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the airline community to brief takeaways from the responses and follow up on priorities and gain further insight. Delta expressed willingness to share the necessary non-proprietary data for a successful collaboration with industry service providers. NASA initiated discussions to understand what is needed from the community for a successful transition plan. These meetings are in preparation for upcoming Space Act Agreements between NASA and interested airlines.

NASA SWS Participation in the DARPA ARCOS Principal Investigator Meeting

POC: [MALLORY GRAYDON](#)

Researchers Mallory Graydon, Paul Miner, and Natasha Neogi participated in the principal investigator's meeting of the Defense Advanced Research Projects Agency (DARPA)'s Automated Rapid Certification of Software (ARCOS) project on June 10, representing the System-Wide Safety project. Graydon and Sushil Birla of the Nuclear Regulatory Commission participated on a government evaluator panel, answering questions from program participants. ARCOS participants briefed DARPA and the government reviewers on their progress, including the creation of data stores for certification evidence, tools for producing test and analysis

evidence on demand, and tools for assembling safety arguments to present and explain safety and security concepts and evidence to certification agents. While ARCOS aims to reduce the cost of certifying software-intensive military systems, the tools and techniques produced may have applications to software used in aviation and spaceflight applications. The web-site for DARPA's ARCOS project is <https://www.darpa.mil/program/automated-rapid-certification-of-software>.

PAAV Holds Tabletop Walkthroughs of Unmanned Aircraft Cargo Scenarios

POC: [ROB FONG](#)

The Air Traffic Management – eXploration (ATM-X) project's Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject held a week-long tabletop walk-through of unmanned aircraft cargo scenarios with subject matter experts, including remote pilots, controllers, and dispatchers, from May 3-7. The goal of the tabletop walkthrough was to highlight shortfalls and gaps that prevent routine unmanned aircraft cargo operations in the National Airspace System within the current Air Traffic Control operating paradigm. A second concept of operations tabletop exercise was held virtually from June 14-18. This exercise was a continuation of the

first tabletop held in May 2021, and new topics were discussed such as clearances, surface operations, launch and recovery, and increased automation considerations. The identified shortfalls from both tabletop exercises will be used to inform trade studies of possible near-term solutions as well as to inform possible automation solutions in the future.

NASA/Northrop Grumman Autonomous Systems Meeting

POC: [ROB FONG](#)

On June 24, the Air Traffic Management – eXploration (ATM-X) project's Pathfinding for Airspace with Autonomous Vehicles (PAAV) subproject met with Northrop Grumman – a potential flight demonstration partner. In the meeting, NASA discussed opportunities for collaboration and in-kind contributions for a potential partnership. Northrop Grumman provided a tour of their automation laboratory and their proposed flight asset and its capabilities during the visit. The information NASA obtained from the meeting will be used to scope a non-reimbursable partnership to support demonstrations to verify PAAV procedures and technologies to enable routine unmanned autonomous cargo operations in the National Airspace System in a relevant flight environment.

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ATM-X Attends AAM Executive Board Airspace Operations Working Group Meetings

POC: [ARWA AWEISS](#) AND [IAN LEVITT](#)

This past quarter the Air Traffic Management – eXploration (ATM-X) Urban Air Mobility (UAM) subproject team attended the Advanced Air Mobility (AAM) executive board airspace operations working group meetings. At the May 21 meeting, the UAM team presented early-term use cases. Savvy Verma, technical lead for airspace procedures and design at NASA’s Ames Research Center in California, walked the group through procedures for entry into a corridor at the boundary between Class E and Class B airspace in the Dallas/Fort Worth operational setting. NASA participants included UAM personnel, the AAM Mission Integration Office, and other members of the executive board. FAA participants included representation from the NextGen Office and multiple safety and operations organizations within the FAA’s Air Traffic Organization. Ian Levitt, NASA co-lead for the working group and principal engineer of UAM, helped facilitate the conversation. A rich discussion unfolded, highlighting the need for the working group to validate key UAM concept of operations principles (e.g. around corridors and provider of services for UAMs) as they pertain to the near- and early-

term integration of UAM operations into the National Airspace System. At the follow-on meeting on June 25, the focus was on early UAM Maturity Level use cases (UML-1/ UML-2). Verma presented again on some work that was conducted in collaboration with Joby Aviation (formerly Uber Elevate) and presented “Early UAM Operations in the Dallas Airspace.” There was constructive dialogue among the 57 participants in attendance.

SWS Develops Shielded Learning Approach Enabling the Enforcement of Safety Properties

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

In June, System-Wide Safety researcher Natasha Neogi, along with Ufuk Topcu and Suda Bharadwaj of the University of Texas at Austin, successfully collaborated in designing a framework which enables the enforcement of safety properties for agents that may possess learning-enabled components. The team formalized safety-oriented constraints derived from FAA regulations by encoding them as temporal logic formulae. However, the well-regulated safety-critical nature of aviation led to multiple competing safety constraints that can be traded off based on the operational context. They then developed, formalized, and demonstrated via simulation a method for facilitating an urban air mobility operation that is both

scalable and minimally violates the temporal logic constraints. Numerical results show that the run time for the proposed algorithm is suitable for very large problems and is backed by theoretical guarantees of correctness with respect to given temporal logic constraints. This work has led to a paper at the 2021 NASA Formal Methods Workshop, two accepted journal articles, and forms a fundamental part of Bharadwaj’s Ph.D. thesis, which has been nominated for the Best Thesis award at the University of Texas at Austin College of Engineering.

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Integrated Communications Navigation and Surveillance (ICNS) Conference

POC: [RAFAEL APAZA](#)

The ICNS Conference was conducted virtually from April 20-22. The program offered three plenary sessions that focused on “Global Harmonization, New Opportunities and Unforeseen Issues,” “The Future Trajectory for ATC,” and “Evolving ICNS Technologies for Drones, AAM, and Beyond.” A technical program presented global communications, navigation, and surveillance research and technology advances. Rafael Apaza of NASA’s Glenn Research Center in Cleveland was the chair of the Special Topics and New Entrants track and served in organizing and moderating the Paper Presentation track. Additionally, a paper titled “Investigation and Evaluation of Advanced Spectrum Management Concepts for Aeronautical Communications” was included as part of the conference proceedings. The paper was co-authored by Eric Knoblock and Rafael Apaza, Hongxiang Li, Zhe Wang, Ruixuan Han, and Nathan Schimpf of the University of Louisville and Nathaniel Rose of HX5. Apaza is also a member of the ICNS executive committee and currently serves as the conference communications chair.

SWS Hosts Virtual Booth at AUVSI Conference

POC: [KAITLYN FOX](#)

NASA’s System-Wide Safety project participated in the Association for Unmanned Vehicle Systems International (AUVSI) Xponential Virtual Conference held from May 4-6. System-Wide Safety volunteers hosted a virtual booth for event attendees. Unlike a traditional booth setting, this event focused on developing connections with other participants with an intended outcome of connecting with relatable organizations to explore potential collaboration opportunities.

“NASA UTM: A Giant Leap for Air Transportation” Video Premieres

POC: [JAEWOO JUNG](#)

On May 6, the “NASA UTM: A Giant Leap for Air Transportation” video premiered through live streaming on YouTube and Facebook with more than 6,000 total combined views thus far. This 24-minute video, produced by the NASA X team, explains what Unmanned Aircraft Systems Traffic Management (UTM) is, why it is needed, and how it is designed to work. The video also features the dedicated NASA team at various field centers together with its government and industry partners, showing the viewers a

better understand of the work accomplished and the testing that is done in real-world settings. The video can be viewed on YouTube at the following website: <https://youtu.be/vepo3q87Grc>.

System-Wide Safety Participates in Advanced Air Mobility Career Day

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

On May 12, Kyle Ellis of NASA’s System-Wide Safety project participated in the Advanced Air Mobility (AAM) career day student panel to engage middle and high school students from across the country, sharing with them on the future of aviation and encouraging the pursuit of STEM education. The all-virtual event included a session titled “How the Digital Generation Will Influence Aviation,” consisting of a panel of three students and Ellis. Matthew Harding, a physics teacher at Iowa City West High School, who was also Ellis’s former high school teacher, participated as the moderator. More than 500 viewers, some representing entire classrooms, were actively tuned into the discussion focusing on areas of excitement and workforce skills needed for NASA to assist the aviation industry to overcome the challenges necessary to realize the vision of AAM. This STEM engagement activity and others like it serve as essential connection

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opportunities with students who represent tomorrow's workforce, seeking to foster the talent pipeline necessary for NASA to accomplish its future missions.

IEEE Robotics and Control Engineering Seminar – UAM Control-Centric Approach

POC: [IRENE GREGORY](#)

On May 14, Irene Gregory of the Air Traffic Management – eXploration (ATM-X) project's Urban Air Mobility (UAM) subproject gave an invited seminar to the Institute of Electrical and Electronics Engineer (IEEE) Control Systems Society entitled "UAM: Control-Centric Approach Addressing Technical Challenges." The talk highlighted major challenges to enable UAM, the most challenging sector of Advanced Air Mobility, and then highlighted research efforts at NASA that address these challenges. The work has been funded by three ARMD projects and is an example of cross-disciplinary collaboration and leveraging of resources. The presentation outlined some of these challenges and current approaches to addressing them. For example, in order to achieve full market potential and access to UAM, vehicle autonomous flight is required. A key barrier to autonomous flight in a large multi-agent system is the handling of off-nominal situations and contingencies in a safe and predictable manner. An

approach to intelligent contingency management was presented along with recent results and open problems. Additionally, she discussed another major barrier to ubiquitous UAM – the noise signature produced by vehicles with multiple rotors. She presented NASA's approach to minimizing such noise within the framework of the acoustically aware vehicle. The recording can be found at <http://ieeecss.org/videos-webinars>.

SWS Participates in Women in Aerospace for Michigan Students

POC: [MISTY DAVIES](#)

On May 15, Misty Davies, project manager of System-Wide Safety, moderated a breakout session panel at the virtual Women in Aerospace conference. The conference was organized for Michigan students, K-12 and academia, and included professional women, college students, and high school robotics students in engineering. Approximately 60 students were in attendance. Panel topics included engineering pathways, preparation for STEM careers, and the importance of resilience to overall life success.

SWS Researchers Present a Paper on IASMS at ISAP

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

On May 18, Lance Prinzal and Paul Krois presented a paper entitled

"Examining the Changing Roles and Responsibilities of Humans in Envisioned Future In-Time Aviation Safety Management Systems (IASMS)" at the International Symposium on Aviation Psychology (ISAP). The paper addressed how today's safety levels would be maintained through an IASMS concept of operations as Advanced Air Mobility transforms aviation. The IASMS represents a system-of-systems perspective on interconnected services, functions, and capabilities needed to proactively reduce risks in increasingly complex operational environments and where the balance between humans and automation changes in relation to such envisioned systems, which may lead to novel human-machine interaction paradigms and human-autonomy teaming for informed contingency management. There were several additional NASA presentations at ISAP and the virtual conference was attended by more than 130 human factors scientists and academics. The proceedings can be accessed at <https://aviation-psychology.org/>. Of special note, former NASA employee Amy Pritchett was made an ISAP fellow for her distinguished contributions to aviation psychology over the years, and in memoriams were included for Key Dismukes of NASA's Ames Research Center in California

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and Tom McCloy of the FAA Flight Deck Human Factors. The next ISAP will be held in 2023.

SWS Researcher Presents Tutorial at 2021 IEEE International Conference on PHM

POC: [WENDY OKOLO](#) AND [STEVE YOUNG](#)

On June 7, System-Wide Safety researcher Portia Banerjee presented a virtual tutorial at the 2021 Institute of Electrical and Electronics Engineers (IEEE) International Conference on Prognostics and Health Management (PHM). Banerjee's presentation, entitled "In-Time Safety Assessment and Risk Prediction for Unmanned Aerial Systems," provided a summary of System-Wide Safety project work as well as a description of diagnostic and prognostic tool implementation to predict risks for Unmanned Aircraft Systems (UAS). While the presentation focused specifically on UAS, the applications of the tutorial techniques encompass various domains. Different prognostics and health management techniques (including Kalman filtering, uncertainty propagation, frequency spectrum analysis, Bayesian Belief network, quantifying uncertainty, etc) were demonstrated and applied to in-time risk prediction. Banerjee also extrapolated

the process of monitoring, assessing, and mitigating risks to more general applications.

SWS Team Introduced SDSP Consolidation Dashboard for Testing

POC: [WENDY OKOLO](#) AND [STEVE YOUNG](#)

In June, a Supplemental Data Service Provider (SDSP) consolidation dashboard was developed to display System-Wide Safety (SWS) services for Unmanned Aircraft Systems (UAS). Two functional SDSPs monitoring battery levels and proximity to static obstacles developed by the SWS team at NASA's Ames Research Center in California have been integrated into the consolidation dashboard. The dashboard visualization of these SDSPs is being tested via simulation at NASA Ames with flight testing scheduled for July at NASA's Langley Research Center in Virginia. During these flight tests, live UAS at NASA Langley and simulated UAS at Ames will communicate concurrently to demonstrate integration and test the consolidation dashboard functionality.

SWS Submits Article in American Airlines Publication

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

In June, the System-Wide Safety (SWS) project submitted an additional article to American

Airlines' Safety Preflight publication. Authored by Kevin B. Gregory of the Fatigue Countermeasures Laboratory at NASA's Ames Research Center in California, the article titled "NASA's Fatigue Countermeasures Laboratory and American Airlines (AA) Fatigue Risk Management System (FRMS)—A Working Relationship" describes American Airlines and NASA's long-standing partnership conducting human factors fatigue research in airline operations. Thus far in 2021, SWS has authored an article in every issue of Safety Preflight, highlighting the collaborative work between NASA and American Airlines. These include the following:

- May issue: "Pilots Causing Safety: NASA and American Airlines Working Together" by John Holbrook. The article highlights the need to understand not only the errors that reduce safety, but the desired behaviors that produce safety and the ongoing collaboration between NASA and American Airlines.
- March/April issue: "Improving Aviation Together: NASA and American Airlines Collaboration" featuring the rich history of SWS and American Airlines working together
- March/April issue: "From Jumpseat to Earthquake: 10 Unexpected Days in Chile" by Lance Prinzel

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- January/February issue: “The Impact of COVID-19 on American Airlines Operations: A New Perspective on Some Old Problems” by Steve Casner, Chad Stephens, and Lance Prinzel
- January/February issue: “Is the Last Inflight Rest Break Really the Best?” by Erin Flynn-Evans and Kevin Gregory

Safety Preflight issues are hosted internally on American Airlines servers. Copies of the NASA articles can be provided upon request by emailing kaitlyn.d.fox@nasa.gov.

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