National Aeronautics and Space Administration

AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

JUL-SEP 2020 | Quarter 4

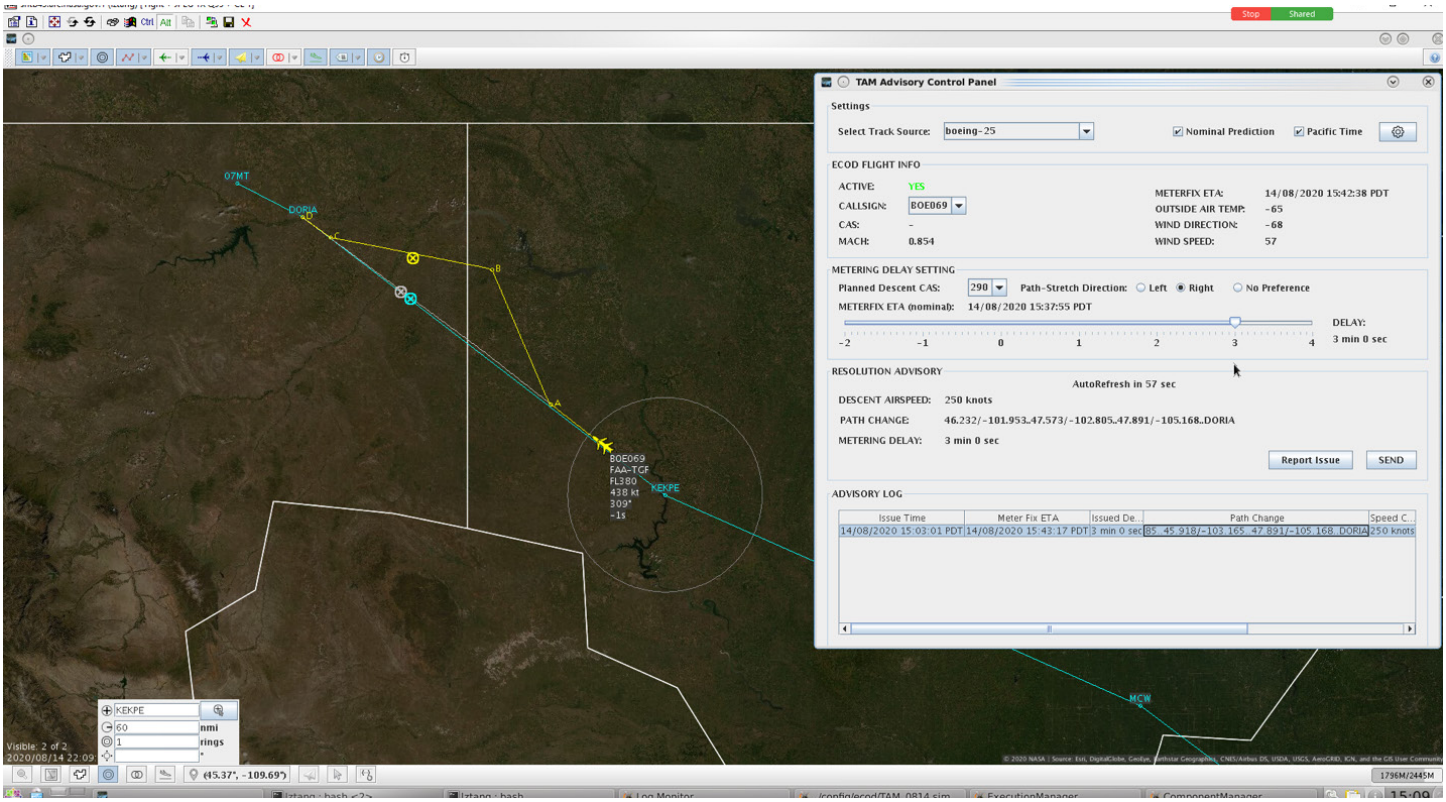
TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

ATM-X Completes TAM Demonstration Flights on ecoDemonstrator

POC: ARWA AWEISS AND
RICHARD COPPENBARGER

The Air Traffic Management – eXploration (ATM-X) project successfully completed two EcoDemonstrator (ecoD) flight trials of NASA's Tailored Arrival Manager (TAM) this past quarter in partnership with Boeing and the William J. Hughes Federal Aviation Administration Technical Center (FAATC). The first test, completed on Aug. 14, was from Glasgow, MT to Charleston, SC and examined the use of increasingly autonomous ground-based air traffic technology, evaluating the effectiveness of TAM solutions in real-world operations. The test went according to plan and the TAM advisories were acceptable to the pilots. As prescribed in the test plan, the advisories were autoloaded but not flown. Using NASA's AutoResolver as its algorithmic engine and testbed for managing data interfaces with Boeing and FAA systems, TAM computed fuel-efficient solutions, speed, and path for metering to an arrival fix on approach to Glasgow Industrial Airport.

TAM is an increasingly autonomous air-ground trajectory management system for arrivals that computes flight paths based on fuel efficient optimized-profile descents while simultaneously satisfying schedule constraints and resolving conflicts. It transmits a new route via digital communications that seamlessly integrates with existing avionics. For ecoD, the TAM user sets a flight delay and turn direction to mimic meeting a traffic scheduling constraint, and then TAM computes the new flight path. The user also has a more autonomous option which lets TAM determine the solution



TAM user interface and testbed traffic viewer

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Boeing 787-10 ecoDemonstrator aircraft on tarmac at Glasgow Industrial Airport, Montana. Upon completion of the flight demonstration program on Sept. 9, the aircraft was scheduled for delivery to Boeing customer Etihad Airways. (Photo courtesy of Boeing)

without prescribing a turn direction. The TAM test was part of a 10-hour maiden flight for the ecoD Boeing 787-10 Dreamliner aircraft from Charleston, SC to Boeing Field, WA. TAM trajectory predictions and solutions used wind forecasts with flight track and intent data transmitted by the aircraft. Solutions meeting user-prescribed flight delay times were sent digitally to the FAA Data Comm Avionics Lab (DCAL) through the TAM user interface. The DCAL instantly translated the TAM solutions into Controller Pilot Datalink Communications (CPDLC) messages and uplinked them to the flight deck. Once received on the flight deck, the crew auto-loaded TAM solutions into the Flight Management System (FMS) and made photographic observations of uplinked messages and associated route modifications on the avionics displays. In this first step of TAM evaluations, no TAM advisories were executed in accordance with the test plan for 2020. A total of three sequential TAM solutions were delivered to the flight deck. Pilots commented that all solutions were received in a timely manner and were loaded into the FMS with no route discontinuities. Comments from Boeing indicated that each TAM solution would have been flyable had the pilots chosen to execute them. After the three TAM solution tests were completed, the 787 performed a near idle thrust descent to the meter fix using FMS Vertical Navigation (VNAV) at a descent speed advised by TAM. The VNAV descent to the meter fix was performed automatically with only minor speed brake inputs required by pilots. The flown trajectory together with downlinked top-of-descent and meter-fix arrival time estimates from the FMS will be compared against corresponding TAM predictions in post-flight analysis. The timing associated with message delivery and pilot review will also be examined

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based on time-stamped CPDLC downlink messages.

The second flight trial conducted on Sept. 9 successfully completed the 2020 ecoD flight test activity. For this test, the Boeing 787-10 test aircraft executed arrivals into Knoxville, TN and Charleston, SC airports that again showcased TAM. Following on the heels of the initial flight demonstration into Glasgow Industrial Airport, this latest test further illustrated the potential for NASA's increasingly autonomous ground-based air traffic technology to leverage the avionics already onboard today's commercial aircraft fleet, ushering in dramatically more efficient management of the arrival airspace at our nation's most congested airports. During the course of three arrival descents (Glasgow, Knoxville, and Charleston), eight scenarios were executed, each prompting a TAM path and/or speed solution to solve a simulated traffic and metering conflict. TAM advisories were again relayed to the ecoD aircraft flight deck via existing FAA digital data communication protocols. Per the test plan, the advisories were autoloaded into the FMS but not flown. The flight crew reported that all eight solutions were received in a timely manner and were loaded into the FMS with no route discontinuities, with Boeing indicating that each TAM solution would have been flyable had the pilots been authorized to execute them. The testbed managed the data interfaces between the different systems. The ecoD 2020 test activity demonstrated the TAM concept for a single commercial flight, though the TAM concept and automation is designed to deconflict and optimize "all" arrivals into a metropolitan area–where the value proposition is most compelling. EcoD 2020 represents a successful first step in that direction.

NASA ATD-2 Phase 3 2020 Stormy Season Training Videos and Presentations

POC: GREG JURO

The COVID-19 pandemic created new training challenges for the Airspace Technology Demonstration-2 (ATD-2) team. Prior to COVID-19, the plan was to provide face-to-face, hands-on training at each of the seven field demonstration sites in the North Texas area which included both flight operator and air traffic control facilities. However, visitors to these facilities were prohibited beginning in March. The restrictions, still in place at present, eliminate the capacity to provide face-to-face training. To successfully continue the training mission for each of the field demonstration sites, the ATD-2 team created a large number of YouTube training videos and slide presentations with embedded audio designed to explain specific functions of the ATD-2 system. The videos can be utilized both as an on the spot training resource by active, operational personnel or in a more formal training environment, and have been placed on web sites that are specific to each field user. For instance, the flight operator videos were made with examples related to that individual airline to further enhance the learning experiences with real-world cases. The following link provides an example of one of the partner operator's training content:

https://aviationsystems.arc.nasa.gov/research/atd2/phase3-training/aa9928985861/index.shtml

This training material delivery approach has the added benefit of allowing later updates with new training resources or other modifications as user capability changes. Feedback from the field users regarding the website training materials has been very positive.

Study Examines Causes of Failure to Comply During Commercial Airline Operations

POC: LANCE PRINZEL, JON HOLBROOK, MICHAEL STEWART AND MISTY DAVIES

At the Applied Human Factors & Ergonomics 2020 Conference held July 16-20, NASA researchers presented research outcomes from an initial study that examined the

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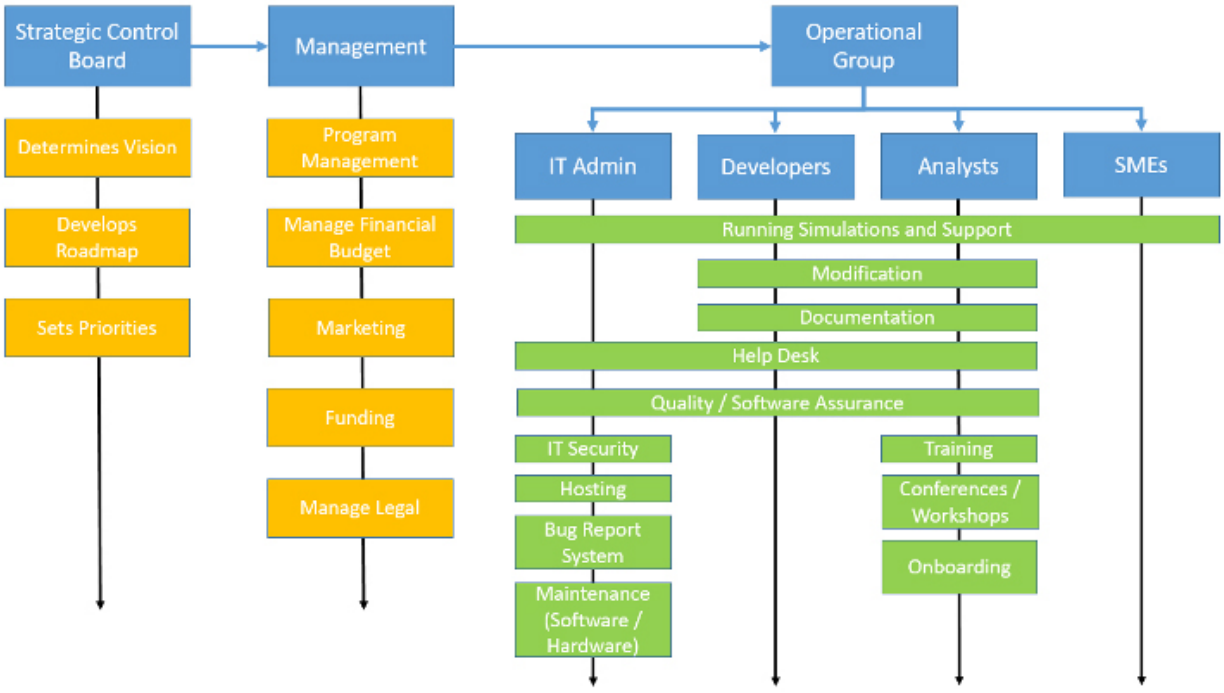
causes of failures to comply with procedures during commercial airline operations. The presentation included a discussion of planned subsequent research efforts focused on (a) in-time system-wide safety assurance and in-time safety management systems; and (b) autonomous systems design for Part 121 commercial flight operations and Advanced Air Mobility's concepts of operations. The current human-contribution-to-safety effort consists of a diverse portfolio of research and development efforts including an ongoing high-fidelity Boeing 737-800 simulation study, planned m:N remote supervisory operations research scheduled for fiscal year 2021, and pioneering data analytics approaches. The team includes researchers from NASA's Langley Research Center in Virginia and Ames Flight Research Center in California, and formal and informal collaborations with American Airlines, Boeing, FAA, LOSA Collaborative, Volpe, and academia. The study was sponsored by the System-Wide Safety project, with cross-project coordination and support from the Transformational Tools & Technologies Autonomous Systems subproject within the Transformative Aeronautics Concepts Program. The NASA report was published as a chapter in the book, "Advances in Safety Management and Human Performance."

ATAC Corp. Testbed Transition Model and Trade-off Study

POC: KEE PALOPO

TATAC Corporation completed an analysis on the Testbed Transition Model Trade-off Study and provided a final briefing to line and project managers at NASA's Langley Research Center in Hampton, Virginia and NASA's Ames Research Center in Silicon Valley, California on July 10. The analysis looked at three support models for future testbed operations: entirely managed by NASA, completely external to NASA, and a hybrid of the two. The briefing focused on an example hybrid case, assuming certain



Proposed support structure functional areas and organization

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percentages of resources provided by NASA and external parties. A spreadsheet for calculating an estimate of the required resources can be customized to allow NASA to perform further analysis.

System-Wide Safety Research Transition Team - Human Factors Meeting

POC: JESSICA NOWINSKI, JON HOLBROOK, AND MISTY DAVIES

On July 21, the NASA/FAA System-Wide Safety Research Transition Team human factors sub-group held a virtual meeting to refocus the group's efforts on human factors needs for Urban Air Mobility (UAM)/Advanced Air Mobility (AAM). The last time that the group met was in 2017. About 60 NASA and FAA civil servants met to discuss the new team goals and objectives and share information about the UAM and AAM human factors work currently underway at each agency. Six FAA representatives and three NASA civil servants, representing both NASA's Langley Research Center in Virginia and Ames Flight Research Center in California, provided brief overviews of relevant work for the purpose of considering potential opportunities for collaboration. Discussions after the presentations were centered on developing shared goals with regard to research needs and approaches, as well as high priority items for a follow-on meeting to be held in about a month.

ATM-X Insight Assessment Closeout Briefing

POC: BARRY BARMORE

On July 28, Booz Allen Hamilton (BAH) presented the outcome of their System Insight Assessment Report to both Airspace Operations and Safety Program management and Air Traffic Management – eXploration (ATM-X) project management. They highlighted the approach used to extract insights from the ATM-X research team and industry stakeholders, including key findings and gaps that were used to refine and focus technical content for the ATM-X Continuation Assessment Review (held July 14), and the transition to Phase 2 of the project. Jackson Floum and Christian McGillan from BAH provided the closeout briefing and led an open discussion with program and project management. The system insight assessment was recommended during ATM-X formulation in fiscal year 2018 as an additional way to engage with the growing aviation community beyond typical academic conferences. In calendar year 2018 and 2019, BAH reviewed ATM-X publications and interviewed researchers from the ATM-X team, and what is now the Advanced Air Mobility project, to collect and synthesize findings and insights. This review culminated in three industry workshops in which the outcomes were presented, and industry representatives gave feedback and identified areas of particular need to them. This process was summarized in a report currently going through the NASA review process to be published as a NASA Contractor Report. The insights gained from this assessment are helping refine and focus the ATM-X Phase 2 portfolio.

ATD-2 Conducts Phase 3 Stormy Season 2021 Training for Envoy Air

POC: GREG JURO

The Airspace Technology Demonstration 2 (ATD-2) team provided two sessions of virtual training to air traffic coordinators at Envoy Air during the last week of July. Envoy Air will be a new flight operator participant during Stormy 2021 and accounts for approximately 20 percent of daily operations at Dallas/Fort Worth International Airport. The site and equipment surveys have been completed to place the ATD-2 equipment inside the Envoy Air operations center, but due to the COVID-19 pandemic and associated visitation restrictions, the equipment has not yet been installed. The placement of the equipment is scheduled to occur as soon as the capability to visit the Envoy Air operations center is resumed. The virtual training covered all aspects of the ATD-2 Metroplex client

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with emphasis on how to evaluate and submit Trajectory Options Set opportunities that are beneficial for Envoy. Envoy has identified five subject matter experts who will be the focal points for use of ATD-2 during Stormy Season 2021. Additionally, after the training was completed, the ATD-2 team provided Envoy with their own training web site link that contains multiple videos and slide shows that provide thorough explanations on various components of the ATD-2 client. The ATD-2 team also has plans to provide face-to-face on-site training at Envoy once visitor restrictions are lifted.

GE Aviation Adopts AdaStress—an Adaptive Stress Testing Tool—with Great Success

POC: GUILLAUME BRAT AND MISTY DAVIES

In early August, Robert Moss, an engineer with General Electric (GE) Aviation, conducted a study using AdaStress, an adaptive stress testing tool developed by Dr. Ritchie Lee in the System-Wide Safety project at NASA's Ames Research Center in Silicon Valley, California. GE has reported that AdaStress discovered "rare errors in FMS (Flight Management System) software" and that "GE Aviation was very impressed with the work and the results [they] got and they intend to continue to use the AdaStress capability as part of their FMS testing strategy." Verification and validation (V&V) of aviation systems can be a difficult, yet necessary, task for the safety of flying the current generation of airplanes. NASA Ames entered into a Space Act Agreement (#403098) in 2016 with GE Global Research Center, allowing GE to try V&V tools developed by Ames researchers on some of the systems they are developing and gauge if they are ready for infusion in various GE business units. AdaStress uses artificial intelligence techniques to perform "smarter" testing and discover subtle errors in complex applications. The research and results have been submitted for publication at the 2020 Digital Avionics Systems Conference.

UAM Operations and Procedures Focus Group Workshop

POC: SAVVY VERMA

An Urban Air Mobility (UAM) operations and procedures focus group workshop kicked off on Aug. 6. The workshop had more than 60 attendees from different FAA organizations including NextGen, Air Traffic Organization, AUV and AJI; Uber; NASA; and Dallas-Fort Worth International Airport. The objective of the workshop was to investigate near-term UAM operations in the Dallas and Los Angeles areas under the Space Act Agreement that Air Traffic Management – eXploration has with Uber. The next planned Annex under the Space Act Agreement will include table-top exercises, part task simulations, human-in-the-loop simulations, and culminate with using data collected by Uber in the Dallas area. The presentations at the kickoff meeting included discussions on FAA's Concept of Operations, previous research at NASA for UAM operations, Uber's timeline and operations, and a review of the FAA's safety risk management process. This workshop also formulated a smaller focus group that will meet twice-monthly and start preparing for the activities planned under the new upcoming Annex. This focus group will meet every 3-4 months to update the larger working group on progress made during the previous months.

Report on Strategic Airborne Trajectory Management Study

POC: ROSA OSEGUERA-LOHR AND MATT UNDERWOOD

On Aug. 17, the Air Traffic Management – eXploration (ATM-X) project's Integrated Diverse Operations (IDO) subproject briefed the ATM-X management team on a significant achievement toward IDO's Batch Study 1 milestone–the exploration of ATM-X Services Prototype Tool and Simulation Environment. The batch study's objectives were to develop a prototype implementation of a Strategic Airborne Trajectory Management (SATM) tool and

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Notification of optimized route

Optimized Trajectory Solutions shown on multi-purpose control and display unit autonomous operations planner page

to create a set of representative Trajectory Based Operations scenarios. Accomplishing these objectives supported creating the simulation environment and documenting the processes for future batch studies to evaluate SATM concepts and technologies. The final outcomes were a methodology and automated scripts to create scenarios that significantly expand high-density airspace simulation capabilities, which were completed at the end of June. The results indicated that the use of SATM in a high-density traffic environment with digital communications could lead to flight benefits. The IDO team is working on two future publications: "Simulation of a Representative Future Trajectory-Based Operations Environment" and "Design and Implementation of a Scenario Creation Process for 2040 Trajectory-Based Operations Simulation."

Testbed Training Exercise

POC: KEE PALOPO

The Air Traffic Management – eXploration testbed team conducted a two-day online training exercise for 20 participants organized by the FAA Technical Center on Aug. 18-19. The participants included representatives from NASA's Ames Research Center in Silicon Valley, California, NASA's Langley Research Center in Hampton, Virginia, FAA Headquarters, FAA Technical Center, Boeing, MITRE, and the École Nationale de l'Aviation Civile (French Civil Aviation University). The testbed training exercise was well-received as a potentially synergistic ecosystem for the community collaboration. Participants suggested extensions to its capabilities–specifically being able to use the Testbed TrafficViewer for human-in-the-loop experiments, such as the NextGen Integration and Evaluation Capability and the Florida NextGen Testbed, being pursued at FAA facilities.

ATD-2 Phase 3 Stormy 21 Kickoff Meeting with Field Demo Partners

POC: GREG JURO

The Airspace Technology Demonstration 2 (ATD-2) team kicked off a virtual planning meeting with field demo partners in the North Texas area on Aug. 26. Participants included representatives from American, Southwest and Envoy Airlines, the National Business Aircraft Association, Dallas Love Field Tower, Dallas-Fort Worth Terminal Radar Approach Control, Fort Worth Center, and the National Air Traffic Controllers Association.

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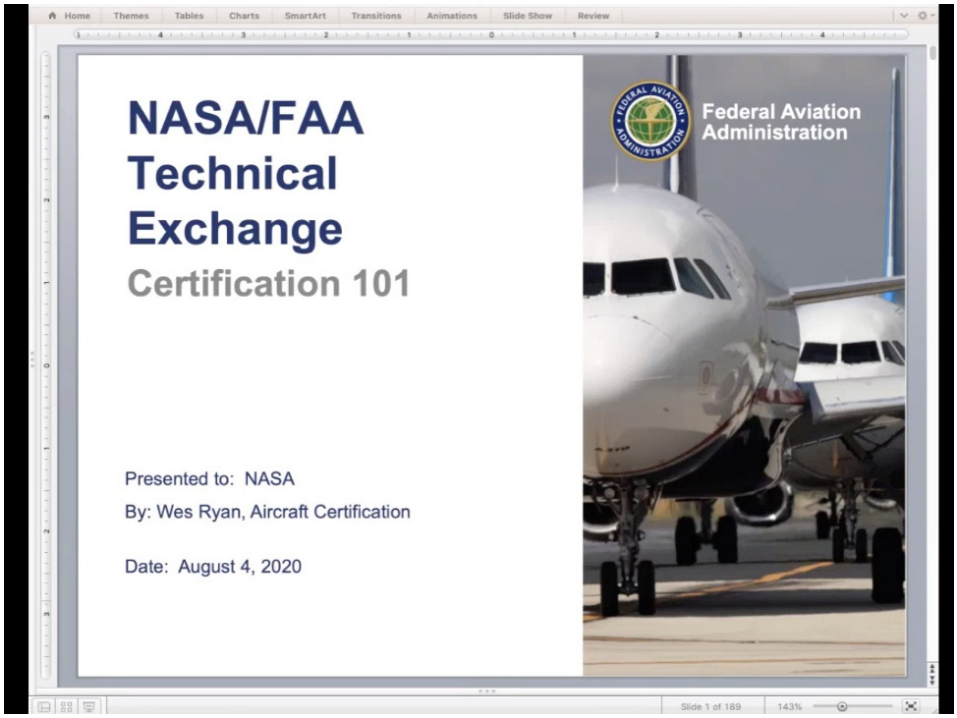
The convective weather storm season in which the ATD-2 Phase 3 evaluation will take place is referred to as "Stormy 21." During the evaluation, the ATD-2 Integrated Arrival, Departure, and Surface prototype system will issue alternative routes in the form of Trajectory Option Sets (TOS), for departing flights in the North Texas terminal area. The participants began discussing collaborations on the process for achieving successful TOS submissions during the next several months and discussed the field demo partners readiness to submit and approve TOS submissions, training needs, and information exchange to compensate for staffing resource availability. The groups also discussed potential enhancements to the ATD-2 system and methods to adapt them. There was unanimous agreement for the continuation of making TOS submissions available to the field demo partners during the next few months, and collaboration with the field demo partners will continue in order to finalize a specific time parameter for the formal phase of testing and data collection associated with Stormy 2021. Data and reports that will assist field demo partners in analyzing TOS opportunities and ATD-2 benefits will continue to be disseminated in upcoming virtual meetings.

SWS Research Transition Team Verification & Validation Subgroup Sponsors Informational Seminars by FAA Experts

POC: AARON DUTLE, EVAN DILL, AND MISTY DAVIES

The System-Wide Safety Research Transition Team verification & validation subgroup sponsored two virtual informational seminars this past quarter. The first took place on Aug. 4, when Wes Ryan, an FAA aircraft certification expert, presented a virtual "Certification 101" tutorial to a group of more than 60 NASA researchers from NASA's Langley Research Center in Virginia and Ames Research Center in California, as well as several other FAA team members, with the goal of introducing aircraft certification to a wider NASA audience. The presentation covered the basic FAA organizational structure, the main kinds of FAA certification, and dove deeply into type certification and the specifics of how new aircraft designs are certified, how updates to existing aircraft designs are certified, and how experimental aircraft obtain their certification. The presentation also covered how the certification process at the FAA has evolved over the years, and what the FAA envisions certification may look like for future aviation



Screenshot of Virtual NASA-FAA Certification Bootcamp 101, attended by over 60 participants from NASA Ames, NASA Langley, and the FAA

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concepts involving autonomy and artificial intelligence.

During the second seminar held Sept. 3, George Romanski, the FAA's chief scientific and technical advisor for aircraft computer software, provided a briefing to a multi-center NASA audience on aircraft software certification. Romanski focused on a software certification package for a platform that supports the ground portion of the Wide Area Augmentation System for the Global Positioning System. Topics also included software design assurance levels, software development and verification plans and processes, requirements traceability, coverage verification, test procedures and test cases, data-coupling analysis, and many others. Actual certification life-cycle data was shown and discussed. After the technical presentation, questions on the software certification process in general and the FAA's approach to certification also were discussed. The presentation was the second in a series of certification discussions with the FAA to cultivate awareness within NASA of how certification works, and to stimulate discussion with the FAA on what NASA has to offer. The presentations were hosted by Aaron Dutle from NASA Langley and were designed to bring together researchers from NASA and the FAA to collaborate on how verification and validation research can be used to provide safety assurance in the National Airspace System.

ASHWG "Low Energy Alerting" Report Published Based on NASA SWS TASA Research

POC: MICHAEL FEARY AND MISTY DAVIES

The FAA's Avionics Systems Harmonization Working Group (ASHWG) published a report (Sept. 4) on "Low Energy Alerting" informed by System-Wide Safety project research on Technologies for Airplane State Awareness (TASA) Safety Enhancement 210 (SE-210). The report was prepared for the Aviation Rulemaking Advisory Committee. In response to National Transportation Safety Board Safety Recommendation A-14-043, the FAA was asked to task a panel of human factors, aviation operations, and aircraft design specialists, such as the ASHWG, to develop design requirements for context-dependent low energy alerting systems for airplanes engaged in commercial operations. The effort was motivated by the Asiana 214 accident for context dependent alerting, and recommends changes to AC25-7D, §25.1303 (c) existing alerting standards and all references to those regulations. The recommendation updates existing fixed alert times with times aligned with alert category, timeliness, nomenclature, etc. without requiring exceptional skill, alertness, or workload. The "Low Energy Alerting" ASHWG report proposes new requirements for context-dependent low energy flight crew alerting systems for airplanes engaged in commercial operations.

ATD-2 Stormy 2021 Briefing to the SCT and FAA Flow Evaluation Team

POC: GREG JURO

On Sept. 14, representatives from the Airspace Technology Demonstration 2 (ATD-2) team conducted a briefing during a joint meeting of the Surface Collaborative Decision Making Team (SCT) and the FAA's Flow Evaluation Team on plans for ATD-2 Phase 3 Trajectory Option Sets Stormy 2021 testing. The SCT consists of representatives from the major U.S. passenger and cargo airlines, general aviation, the FAA, and NATCA. The briefing was a subsequent presentation to a high-level overview of Stormy 2021 that was provided to this group in July, and provided more details regarding various elements of the plan that the ATD-2 team has developed. The focus of the briefing was to outline operational plans and enhancements that the ATD 2 team will be making to the system to increase Trajectory Option Sets (TOS) opportunities during the coming months. Specific topics covered included the platforms designed to accomplish training for field users such as tutorial videos, additional use case scenarios that could generate more TOS opportunities, and various

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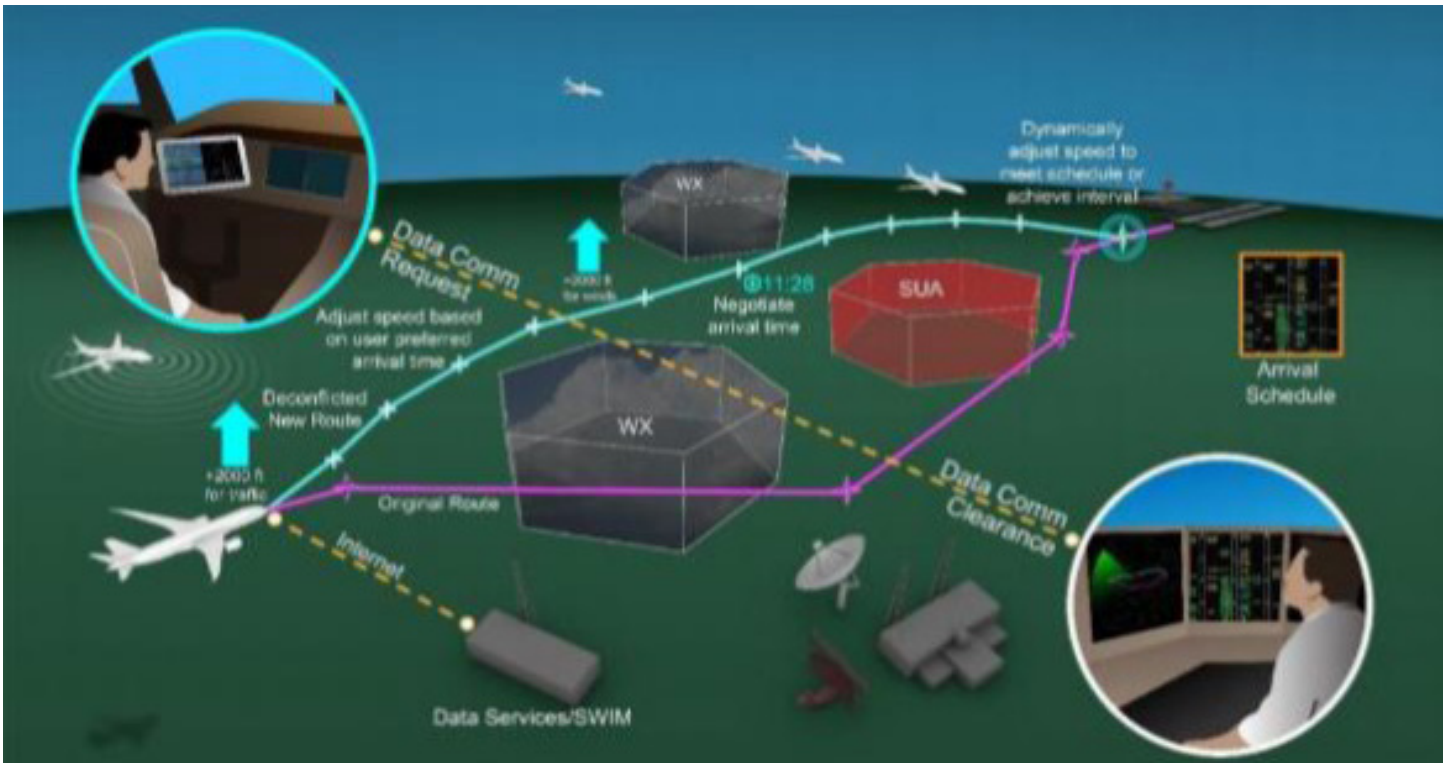
methods to accurately calculate reroute benefit savings. The briefing was received well, and numerous questions were answered regarding the implementation plan.

Exploration of Air Traffic Management Services Final Demonstration

POC: MATT UNDERWOOD AND ROSA OSEGUERA-LOHR

On Sept. 14, the Integrated Diverse Operations subproject in the Air Traffic Management – eXploration (ATM-X) project provided an end-of-year overview and demonstration of the work conducted under this research activity. This work was the culmination of a year and a half of planning and execution, supporting one of the milestone deliverables planned for the Integrated Diverse Operations subproject conducted under ATM-X Phase 1. Deliverable products of this area of work include seven publications, Strategic Airborne Trajectory Management (SATM) technology prototypes, and internal documentation. Scenario development software and scenario files are also available and documented for future use. Impacts of the work conducted under this research activity. This work was the culmination of a year and a half of planning and execution, supporting one of the milestone deliverables planned for the Integrated Diverse Operations subproject conducted under ATM-X Phase 1. Deliverable products of this area of work include seven publications, Strategic Airborne Trajectory Management (SATM) technology prototypes, and internal documentation. Scenario development software and scenario files are also available and documented for future use. Impacts of this effort are outreach and pull from industry, including from five major airlines, multiple avionics manufacturers, media, and the FAA. The objective for the Exploration of ATM Services was to define initial concepts for dynamic, intelligent trajectory optimization and negotiation that enable increased user operational autonomy and leverage existing or soon-to-exist FAA NextGen and avionics capabilities. Work conducted included development of requirements and development of a prototype reference implementation of a strategic trajectory management service, which was demonstrated in operation.



Demonstration of SATM Service Prototype had two parts that highlighted two options: a Strategic Trajectory Optimization demo (KLGA to KDEN), and a Time-Compliant Optimization (KLGA to KORD)

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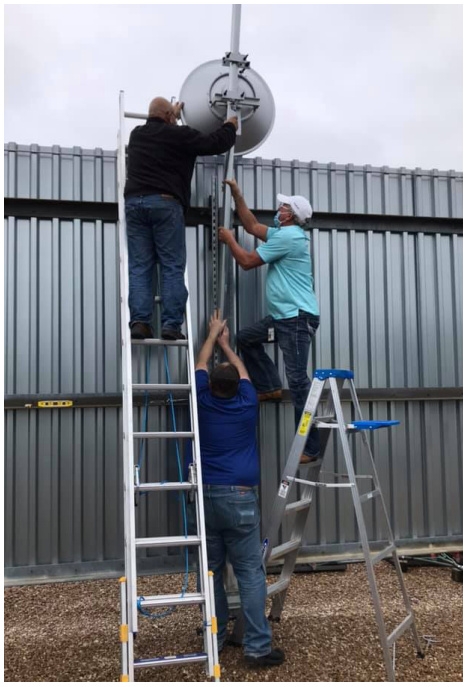
This map shows the physical locations of NTX, DFW, and Envoy's headquarters. The blue line is the datalink path which connects Envoy to NTX.

Envoy mounting the network dish to the roof of their building.



ATD-2 Hardware and Displays Fully Deployed at Envoy Air

POC: KEENAN ROACH

In support of the Airspace Technology Demonstration 2 (ATD-2) subproject Phase 3 activity, personnel at NASA's North Texas Research Station (NTX) deployed an ATD-2 system at the headquarters of Envoy Air on Sept. 16. Envoy operates the regional aircraft fleet for American Airlines—about 22% of the total American Airlines presence and 17% of overall operations at Dallas-Fort Worth International Airport (DFW). The addition of Envoy to the ATD-2 Phase 3 data collection will significantly increase the number of data points collected during the test and allow analysis of how the advisory tools impact the operations of regional carriers. Under normal conditions, the NTX team would have installed the ATD-2 equipment at Envoy, but given COVID-19 operating conditions, the NTX team instead created a set of instructions and a kit with the hardware Envoy personnel needed to make a secure, wireless network connection to the NTX facility via another NASA-managed secure connection at DFW. Envoy verified that their ATD-2 displays are operating properly. Envoy will complete training and familiarization with the tool before spring storms arrive.

NASA Participates at Virtual Air Traffic Controller Association Technical Symposium

POC: IAN LEVITT AND BARRY SULLIVAN

NASA's Air Traffic Management (ATM) research and development was once again highlighted as part of the annual Air Traffic Controller Association (ATCA) technical symposium. Scheduled to take place May 12-14, the symposium was postponed due to the COVID-19 pandemic and held as a completely virtual conference from Sept. 14-18.

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This included modifying the traditional "Tech Center Tuesday" event into a virtual "Tech Center Week." The symposium's theme was "Advancing Aviation into the next Decade and Beyond." NASA was well represented during many of the plenary sessions with the following presentations:

- Akbar Sultan, director of Airspace Operations and Safety Program (AOSP), presented the "Laying the Groundwork to Enable Future Technology" panel.
- Vince Schultz of NASA's Langley Research Center in Virginia presented "X-57 Maxwell and Electric Propulsion Tech Talk."
- Parimal Kopardekar, director of NASA's Aeronautics Research Institute, presented on the "Evolving NAS Services for Emerging Aircraft Operations" panel.
- John Koelling, project manager of System-Wide Safety, presented on the "Safety in an Ever-Evolving Airspace System" panel.
- Barry Sullivan, technical integration manager of AOSP, presented on the "ATCA Technical Symposium Recap and Look Forward Roundtable Discussion."
- Shawn Engelland, project manager of Airspace Technology Demonstrations, also presented.

In addition, Tech Center Week featured virtual technical tours, demonstrations, and exhibits in a variety of aviation fields from over 45 different projects, programs, and organizations. NASA had two virtual exhibits showcasing the program's research portfolio. As part of the virtual interactive exhibit, the FAA included an eight-minute video on collaborative initiatives in Emerging Operational Concepts and Technologies highlighting some of their collaborative work in the area of Advanced Air Mobility (AAM), including recent and planned collaboration with NASA's Langley Research Center in Hampton, Virginia. In the second half of the video, the viewer is taken on a narrated virtual electric Vertical Take-Off and Landing flight from Atlantic City International Airport to downtown Atlantic City, NJ. The flight was simulated using the Urban Air Mobility (UAM) vehicle simulation capability, also known as the UAM Flyer. The reference trajectory flown by the Flyer and other neighboring flights was provided by the UAM mission planner capability, all located in NASA Langley's Air Traffic Operations Laboratory. These are two technologies that have been developed by the Crew Systems and Aviation Operations Branch in support of the ATM-X UAM sub-project as part of the research to define requirements for air traffic management systems for UAM and AAM. Future collaborations between the FAA Technical Center and Langley include developing and accrediting joint simulation capabilities as part of a live, virtual, constructive environment for Emerging Operational Concepts and Technologies. A direct link to the video is below, best viewed in Chrome.

https://faatechnicalcenter.com/subPages/emergingOperations/Concepts_Technologies.html

Data Analysis Support for AAL Learning and Improvement Team Flight Observations

POC: JON HOLBROOK AND MISTY DAVIES

Members of System-Wide Safety (SWS)'s human contributions to safety team held a working meeting with American Airlines on Sept. 21 to discuss analysis of data from approximately 100 airline flight-line observations of resilient pilot performance. This data represents the first systematic observations of operational flight focused explicitly on capturing "desired" crew behaviors. The goal of this collaboration is to identify a language and approach for observation-based learning from resilient performance that could be shared broadly with the aviation community. To date, most systematic learning in aviation has focused on learning from undesired behaviors (e.g. failures, errors) that are operationally rare, yielding limited data to conduct safety analyses. This collaboration represents a unique opportunity to extend SWS project research

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and promote an American Airlines initiative, both designed to examine the efficacy and value of flight crew observed resilience behavior for enhancing aviation safety. This working meeting included multi-center collaboration from both NASA's Langley Research Center in Virginia and Ames Research Center in California. In attendance from NASA Langley were Kathryn Ballard, Jon Holbrook, Lance Prinzel, and Chad Stephens. Representatives from NASA Ames included Immanuel Barshi, Dorrit Billman, Jolene Feldman, Alan Hobbs, Joel Lachter, Bryan Matthews, Randy Mumaw, and Brian Smith.

NASA ATM Testbed and ICAROUS Connectivity Test

Testbed Connectivity with ICAROUS

POC: KEE PALOPO

The Air Traffic Management – eXploration project is developing Testbed, an interconnected air traffic simulation capability, to help accelerate the introduction of advanced technologies into the National Airspace System. Testbed provides easy-to-use and easy-to-connect support for various applications as plug-ins. Teams from NASA's Ames Research Center in California and Langley Research Center in Virginia successfully completed a connectivity test of a safety-centric system for Unmanned Aircraft Systems (UAS) operations, as a plugin to Testbed, on Sept. 28. This safety-centric system, known as Independent and Configurable Architecture for Reliable Operations of Unmanned Systems (ICAROUS), is an onboard software system that enables the modular integration of mission-specific logic, sensor technologies, and a collection of core applications. The core applications implement capabilities such as detect and avoid, keep-in and keep-out geofencing, path planning, return to mission, and merging and spacing. ICAROUS is publicly available under NASA's Open Source Agreement at https://github.com/nasa/icarous. During the connectivity test, ICAROUS, an air-taxi-vehicle simulator called the "UAM Flyer," and a traffic simulator and mission planner called Toolkit for Integrated Ground and Air Research were connected to Testbed, which enabled the sharing of aircraft data. As shown in the figure below, the UAM Flyer traveled from Foster City, CA towards South San Francisco, CA and an ICAROUS detect-and-avoid algorithm generated a path deviation for the Flyer to avoid another flying aircraft (not shown). The successful connectivity demonstrated in this test will enable the ICAROUS team to participate in future UAM experiments that leverage Testbed.

X-3 Highlight Scenario 2 Testing Commences Sept. 30, 2020

POC: SAVVY VERMA

On Sept. 30, the Urban Air Mobility (UAM) sub-project within Air Traffic Management – eXploration (ATM-X) will start its second phase of testing in a series of lab tests

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called "X-3" with airspace partners to prepare them for the National Campaign (NC) scheduled to run in 2022. This phase of testing will focus on NC's Scenario 2 that involves a re-route for a UAM flight due to a constraint similar to a temporary restriction posed on the airspace. X-3 is scheduled to end in mid-December 2020. The third phase of the test will focus on Scenario 3 data collection. In total, the three scenarios include UAM flight following nominal trajectory, re-route of a UAM flight due to a temporary flight restriction, and operations dealing with off-nominal situations like go-arounds. Eight partners have successfully completed at least one of the three connectivity tests that include testing with credentials and connecting with data collection tools. Recently, four partners started validation tests and three have successfully completed them, demonstrating their systems meet the requirements to complete the Scenario 1 test for X-3. Five partners have started Scenario 1 connectivity and data collection and one has successfully completed it. Several partners are scheduled to start Scenario 2 tests in the near future, in which ATM-X is working with industry and the FAA to develop an airspace management system for vehicles expected to operate in urban areas. A key characteristic of this system is leveraging the innovative UAS Traffic Management (UTM) system architecture and partnering with industry airspace service providers and the NC sub-project in Advanced Air Mobility to collaboratively develop, test, and evaluate this system in the field with aircraft. ATM-X UAM is collaborating with a group of 11 airspace industry partners to ensure they are ready by integrating their technologies and testing them in the lab prior to deploying the system into the field.

FAA/NASA Quarterly Review: Urban Air Mobility

POC: IAN LEVITT AND KEVIN WITZBERGER

The Air Traffic Management – eXploration Urban Air Mobility (UAM) sub-project met with the FAA NextGen organization for the virtual NASA/FAA quarterly review on Sept. 30. The FAA briefed the progress on the NextGen UAM ConOps. Plans to mature the concept include initial systems engineering work and coordination across other FAA lines of business, as well as the National Air Traffic Controller's Association. NASA provided an update on the UAM sub-project planning, including changes within the sub-project management team. NASA also provided technical briefings to the FAA covering the status of developing the UAM Airspace Roadmap towards the UAM Maturity Level-4 (UML-4), past and upcoming UAM simulations, and partnership with Uber. There was a healthy technical exchange and discussion on how to coordinate the increasing level of effort on both sides. Both NASA and the FAA recognized that the NASA/FAA Executive Board Working Groups are the best way to stay coordinated.

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Unmanned Aerial System Traffic Management (UTM) Awarded 2020 NASA Government Invention of the Year

POC: RON JOHNSON

A NASA patent for traffic management of unmanned aircraft system (UAS) vehicles was awarded the 2020 Government Invention of the Year. This technology, called "Unmanned Aerial System (UAS) Traffic Management (UTM) to Enable Civilian Low Altitude Goods and Service Delivery by UAS," allows UAS to maintain safe and efficient operations for goods and services delivery. The invention transforms traditional, human-centric air traffic management into a modern, machine-centric, federated approach. In traditional air traffic management, a centralized authority provides services to keep the airspace safe and accessible. In UTM, the FAA delegates some of that authority to other entities to provide similar services to directly support the operators. In addition, those operators may receive services from different service suppliers. These additional services may include low-altitude weather information, congestion management, terrain avoidance, route planning, re-rerouting, separation management, and contingency management. This novel ecosystem requires a federation of services that are interconnected and communicating via well-defined interfaces and protocols. More information on NASA UTM is at https://utm.arc.nasa.gov.

UTM Chief Engineer Presents at ARMD Technical Seminar

POC: JOEY RIOS

On July 7, the Unmanned Aircraft System Traffic Management (UTM) project chief engineer, Joseph Rios, conducted an online virtual Aeronautics Research Mission Directorate technical seminar titled "Commercial Drone Operations at Scale: Testing NASA's UAS Traffic Management Concept in the Urban Environment." The seminar included an audience of more than 250 people. Rios presented the potential use of unmanned aircraft systems (UAS), or drones, for applications from many industries, including package delivery, agriculture, mapping, security, inspection, public safety, and others. He also spoked about why UTM is the key to enable safe and efficient operations of the drones at scale. One aspect of UTM that was discussed is that it does not rely on a centralized system to provide management services, as have been traditionally provided in commercial aviation. Rios described how the UTM ecosystem leverages UAS Service Suppliers to interoperate and support operators in sharing their intents, strategically deconflicting, providing appropriate airspace updates, and other key functions. He also highlighted how the NASA investment in this research and technology has accelerated a growing industry and enabled many novel roles in this emerging ecosystem, and showcased NASA's capstone UTM demonstration involving flight tests in urban environments with more than 30 external partners.

ATCA's Blue Skies Initiative Launches Platform for Industry Engagement

POC: PARIMAL KOPARDEKAR

On Aug. 5, the Air Traffic Control Association (ATCA) formally launched an industry engagement platform to inform the public and seek stakeholder inputs, from traditional aviation (airlines, air traffic controllers, Department of Defense, FAA) and new entrants (commercial space companies, the Unmanned Aircraft Systems (UAS) and UAS Traffic Management communities, Advanced Air Mobility innovators, and high altitude operators), as well as aviation ports (airports, spaceports, and vertiports) on ATCA's Blue Skies Initiative. The Blue Skies Initiative is an industry-government collaborative effort that will deliver a future-ready framework for modernizing the National Airspace System that defines a short-, mid-, and long-term vision for aviation while ensuring optimization of resources for all Air Traffic Management stakeholders and

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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. Parimal Kopardekar, director of NASA's Aeronautics Research Institute, represents NASA on the Blue Skies Initiative executive committee. Visit the industry engagement platform at https://www.atca.org/blue-skies-initiative.

UTM Wins 2020 AIAA San Francisco Section Engineering Team of the Year Award

POC: RON JOHNSON

On Sept. 8, the Unmanned Aircraft Systems Traffic Management (UTM) project was awarded the prestigious 2020 AIAA San Francisco Section Engineering Team of the Year Award. The UTM team receiving this award also includes the FAA and the team's industry partners. The award is in recognition of "The UTM system being the key enabler to manage, integrate and expand the scope, scale and speed of the existing ATM system by allowing drones to safely participate in our airspace and help unlock an estimated $100 billion drone industry. UTM research, its successful field demonstrations, and initial operational capabilities have empowered an ecosystem and stimulated investments from Fortune 500 companies like Amazon, Alphabet, FedEx, Uber and UPS. In addition, startups have received over $3 billion in external funding for UTM and UAS related work. Drones are paving the way for the Urban Air Mobility ecosystem which in itself could be a $1.5 trillion market by 2040." The date and time of a virtual award ceremony and banquet will be scheduled in the near future.

NIST Invites NASA Researcher Dr. Evan Dill - Panelist on the Use of PNT

POC: EVAN DILL AND MISTY DAVIES

On Sept. 15, Evan Dill of NASA's Langley Research Center in Hampton, Virginia was invited to participate on a public panel of representatives from the federal government on strengthening national resilience through the responsible use of Positioning, Navigation, and Timing services. This panel was organized by the National Institute of Standards and Technology to initiate the national directive laid out in Executive Order 1395. Dr. Dill was invited to be the NASA panel representative along with other government officials including Jim Platt, chief of strategic defense initiatives at the Department of Homeland Security; and Karen Van Dyke, director of positioning navigation and timing and spectrum management for the Department of Transportation. The Alternative Positioning, Navigation and Timing testing that NASA's System-Wide Safety project has hosted during the last few years will be critical in delivering on the aforementioned Executive Order. Continued integration with this community is expected to be very beneficial to continuing efforts in System-Wide Safety.

ATD-2 Machine Learning Services Featured at NASA Data Science Month

POC: JEREMY COUPE

NASA Data Science Month is structured as a multi-day, virtual mini-conference hosted by the NASA Headquarters Information Technology and Communications Division and the Information Resources Directorate at NASA's Johnson Space Center in Houston. The primary goal is to share and inform the Agency's data community of current and future activities in the field of data science. September 2020 topics included COVID-19, artificial intelligence, and machine learning. Dr. Jeremy Coupe of NASA's Ames Research Center in California presented at the Sept. 17 meeting on "ATD-2 Real-time Machine Learning Services Powered by SWIM." The modern-day National Airspace System (NAS) is powered by System Wide Information Management (SWIM), a digital data-sharing infrastructure that provides a high-fidelity view of the lifecycle of a flight. The real-time data feeds within SWIM can be leveraged to help drive efficiencies in the NAS. In his talk, Dr. Coupe

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showed examples of different machine learning services being developed by Airspace Technology Demonstration 2 to model airport surface operations. The machine learning services will form the building blocks of a predictive engine that alerts flight operators to delay savings opportunities within the terminal airspace.

System-Wide Safety Participates at Flight Safety Foundation's Learning from All Operations Webinar

POC: JON HOLBROOK AND MISTY DAVIES

On Sept. 29, Jon Holbrook from the System-Wide Safety (SWS) project participated as an invited panelist in the Flight Safety Foundation's Learning from All Operations webinar. The goals of this virtual webinar were to globally promote the practical implementation of the concepts of system safety thinking, resilience, and safety artificial intelligence and to discuss what the aviation industry can collectively do to advance these safety concepts. In his briefing, Dr. Holbrook described his System-Wide Safety project team's work, focused on systematically collecting and analyzing data on safety-producing behaviors to support development of in-time safety assurance applications. Erik Hollnagel (University of Jönköping, Sweden), Max Butter (Lufthansa), and Dana Schulze (National Transportation Safety Board) also appeared. The event comprised of briefings from each of the four invited speakers, followed by a question-and-answer panel discussion with the audience. The event was attended by an international audience of over 440 participants. The Flight Safety Foundation and event panelists plan to write a white paper, based on the outcomes of the event that can be shared with the international aviation community.

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