

AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

JAN-MAR 2020 | Quarter 2



ATD-2 Benefit Milestone 3
Achieved: 100,000 Urban Trees

ecoDemonstrator Lab Series 15
Completed

AOSP IN THE NEWS

[NASA Advances Urban Flying Transport Plans With 17 Companies](#)

ZDNet (3/4, Chanthadavong) reports “the National Aeronautics and Space Administration (NASA) has now signed Space Act Agreements with 17 companies from the aviation industry, including Boeing, Uber, and AirMap, as part of its plans to bring air transport solutions and systems in and around densely populated metro areas through its urban air mobility (UAM) grand challenge. According to the agency, if UAM is fully implemented it could enable the air

transportation of things like small packages, taxi services, medical services, such as patient ambulance transportation, and cargo delivery to regional or rural communities.”

[NASA Adds 17 Companies to UAM Grand Challenge](#)

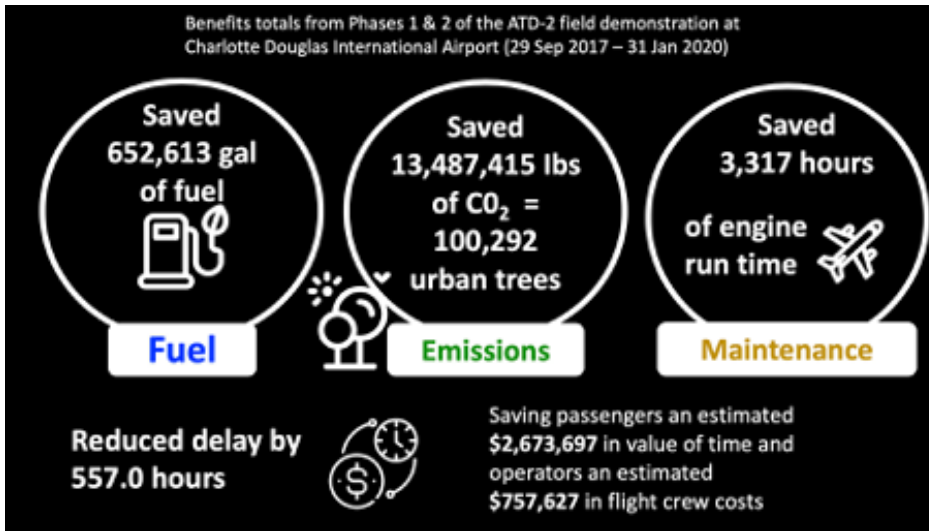
ATCA Headline News (3/6) reports “NASA signed agreements with 17 aviation companies to support its Urban Air Mobility (UAM) Grand Challenge technology demonstrations on Tuesday. Each company provided a proposal in one of three categories: developmental flight testing, developmental

airspace simulation and vehicle provider information exchange. The new agreements will focus on developmental testing in advance of the first Grand Challenge, which is planned for 2022.”

[NASA Lays Out Plans to Enable Advanced Air Mobility](#)

Aviation Week (3/25) reports “NASA has renamed its Urban Air Mobility Grand Challenge the Advanced Air Mobility National Campaign, a seemingly simple name change that signals recognition that industry’s interest is in more than just downtown air transportation.”

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS



Benefit results from ATD-2 field demonstration at Charlotte Douglas International Airport

ATD-2 Benefit Milestone Achieved: 100,000 Urban Trees

POC: [HANBONG LEE](#)

As of January 31, the Airspace Technology Demonstration 2 (ATD-2) team achieved its benefit milestone of 100,000 urban trees planted through the ATD-2 field demonstration at Charlotte Douglas International Airport, since being deployed on September 29, 2017. By holding departures at gates through surface metering during peak periods and pre-scheduling approval request (APREQ) flights at gates, as well as renegotiating the release times of APREQ flights while taxiing through ATD-2 Integrated Departure Arrival Capability capabilities, it is estimated that 652,613 gallons of

fuel savings and 13,487,415 pounds of CO₂ emission reduction have been achieved so far, with a total of 3,317 hours of engine run time reduction. The amount of CO₂ savings is equivalent to planting 100,292 urban trees, according to the formula developed by the U.S. Environmental Protection Agency.

Unprecedented Number of Aircraft in Airspace and Traffic Operations Simulation

POC: [BILL BUCK](#)

On January 13, a simulation scenario featuring an unprecedented number of aircraft was successfully run. For researchers at NASA's Langley Research Center in Virginia, this marked a milestone achievement in their ability to

create realistic air traffic scenarios. During testing for the "Exploration ATM Services Batch Study 1," a simulation scenario with an unprecedented number of aircraft was successfully run using the Airspace and Traffic Operations Simulation. This scenario had 1,553 Aircraft Simulations for Traffic Operations Research (ASTOR) aircraft flying (maximum of 289 simultaneous operations), and an additional 447 background aircraft. Each instantiation of ASTOR is a medium-fidelity networked and interactive desktop simulation of a commercial transport aircraft and its flight deck systems. The simulation scenario was built with researcher-developed automated scripts from real-world recorded aircraft traffic position data, gridded 4D wind and temperature data, convective weather, and Special Use Airspace data from May 23, 2018. Prior to this, the largest total number of ASTOR aircraft in a single simulation scenario was 500. Before this effort, air traffic scenarios that replicated real-world conditions were created using a labor-intensive manual process, and traffic scenarios that featured this number of ASTOR aircraft were contrived and not based on actual flight routes. The process and automated scripts used to generate simulation scenarios for batch study 1 represent a significant

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

step forward in the state-of-the-art in scenario generation and air traffic simulation. The Air Traffic Management-eXploration Increasing Diverse Operations (IDO) subproject exploration of air traffic management services element seeks to increase user flexibility achieved by increased operational autonomy and system-wide predictability simultaneously by using dynamic, intelligent trajectory optimization and negotiation. The goal of the exploratory batch study 1 is to create simulation scenarios representative of a 2040 Trajectory Based Operations environment, along with a documented process, that can be used in future batch studies for the IDO research.

SAE S-18 Aircraft and System Development and Safety Assessment Committee Meeting

POC: [MALLORY GRAYDON](#),
[TERRY MORRIS](#) AND [JOHN KOELLING](#)

On January 13, researcher Mallory Graydon from NASA's Langley Research Center in Virginia participated in the SAE S-18 Aircraft and System Development and Safety Assessment Committee Meeting in San Diego. SAE S-18 is now finalizing proposed revisions of the Aerospace Recommended Practice (ARP) 4754A safety process standard and the ARP 4761 safety analysis standard, and

is drafting aerospace information reports on Unmanned Aircraft Systems, the use of systems theoretic process analysis in aerospace applications, and the use of system models, modeling tools, and modeling analysis tools. A complete writeup on the progress is available.

Joint Authorities for Rulemaking on Unmanned Systems Working Group 6 Meeting

POC: [MARCUS JOHNSON](#)

NASA's Unmanned Aircraft System (UAS) Traffic Management (UTM) project participated in the recent Joint Authorities for Rulemaking on Unmanned Systems (JARUS) Working Group 6 (Safety and Risk Management) meeting held in Wellington, New Zealand, from January 13-16. The working group

included representation from the following government organizations: the FAA, New Zealand Ministry of Transport, Civil Aviation Authority of New Zealand, the Australian Civil Aviation Safety Authority, French Civil Aviation Authority (Direction générale de l'aviation civile), Civil Aviation Administration of China, and Civil Aviation Administration-Denmark. There were also representatives from several airspace providers, including Uber, Wing, and Airbus. Operator and manufacturer representation included Matternet and Boeing. The working group's main focus was on state-of-the-work products, a UTM Annex, and an out brief of each of the work products. Overall, the meeting was productive, and NASA is seen as adding value to the acceleration of UAS regulation development and



Participants attend the JARUS Safety and Risk Management Working Group in Wellington, New Zealand

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the UAS technical development/standards from both industry and global civil aviation authorities through this JARUS venue.

National Campaign Visit to Choctaw Nation

POC: [SHIVANJLI SHARMA](#)

On January 17, NASA's Advanced Air Mobility (AAM) National Campaign team visited the Choctaw Nation Headquarters in Oklahoma,

as part of a meeting discussing the tribe's buildup of capabilities in support of the FAA's Integration Pilot Program (IPP) as well as Urban Air Mobility (UAM) testing. The meeting focused on infrastructure and design of the Choctaw Nation's range to support IPP, UAM, and their applications for transport, agriculture, and safety services. The meeting included participation from Administrator Bridenstine, FAA officials, the National Campaign

project management lead, the National Campaign Airspace Test Infrastructure lead, as well as Bell, Oklahoma State University, Noble Research Institute, GE AiRXOS, and other industry partners. The meeting highlighted infrastructure needs for small Unmanned Aircraft Systems and UAM vehicles with ground-based detect and avoid radars and advanced weather infrastructure. Discussions during the meeting focused on data and testing needs required to establish a regulatory framework that will permit more complex low-altitude operations as well as higher altitude operations for cargo and passenger carrying UAM vehicles.



NASA visits the Choctaw Nation in Oklahoma in support of the AAM National Campaign. Pictured left-to-right: Starr Ginn, National Campaign lead; Jim Bridenstine, NASA administrator; and Shivanjli Sharma, National Campaign Airspace Test Infrastructure lead

ATM-X Participates in the Vertical Flight Society Transformative Vertical Flight 2020 Meeting

POC: [DAVID THIPPHAVONG](#) AND [WILLIAM CHAN](#)

From January 21-23, the Air Traffic Management-eXploration (ATM-X) project participated in the Vertical Flight Society Transformative Vertical Flight 2020 meeting in San Jose, California. There were about 60 technical presentations on topics including aerodynamics, acoustics, Urban Air Mobility (UAM) design and configurations, and electric Vertical Takeoff and Landing performance. In addition, there were about a dozen panels on topics such as manufacturing,

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crashworthiness, infrastructure, ridesharing, and cargo delivery. There were keynote speakers from government, industry, and academia, including representatives from the FAA, U.S. Army, the White House Office of Science and Technology Policy, Uber, and Bell. The ATM-X project management team conducted valuable interactions with other attendees, including potential collaboration opportunities. ATM-X was able to hear a wide range of perspectives to help shape ATM-X UAM research. Noise impacts continue to be a top concern of industry and the UAM community at large. The investor panel made a point that more emphasis should be placed on infrastructure, including airspace access to enable UAM operations.

System-Wide Safety Visit to Swiss Air Lines Headquarters

POC: [NIKUNJ OZA](#) AND [BRYAN MATTHEWS](#)

From January 22-23, AOSP researchers Nikunj Oza and Bryan Matthews from the System-Wide Safety project visited Swiss Air Lines Headquarters in Zurich, Switzerland. The purpose of their visit was to discuss and set up two algorithm implementations (Multiple Kernel Anomaly Detection and Deep Temporal Multiple-Instance Learning), test them to confirm they find interesting anomalies, and then set up Swiss Air Lines personnel to use the algorithm implementation.

This work is being conducted through a non-reimbursable Space Act Agreement between NASA and Swiss Air Lines that includes collaboration on developing machine learning capabilities.

Unmanned Aircraft Safety Team Meeting

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

On January 30, AOSP researchers Steve Young and Becky Hooey participated in the Unmanned Aircraft Safety Team (UAST) meeting in Anaheim, California. The meeting was held in conjunction with the Helicopter Association International (HAI) - Heli-Expo in Anaheim, California, from January 27-30. The UAST is a government/industry group chartered in 2016 to develop consensus-based and data-driven safety enhancements for Unmanned Aircraft System (UAS) operations. The team meets quarterly, and generally consists of approximately 75 people representing industry and government organizations spanning the UAS community. At this meeting, agenda topics included status reports from the four working groups: Data Reporting, Mitigation, Assurance, and Communications/Outreach. In support of the Data Reporting working group, Young and Hooey have been working with the FAA to enhance NASA's Aviation Safety Reporting System to enable better reporting of UAS

incidents, as well as providing better analysis of reports regarding identifying safety-relevant trends and precursors. Hooey presented the status of this initiative, which will occur over the next several months with funding from the FAA, implementation by NASA, and outreach via UAST to an emerging and large population of data/event reporters. In support of the Mitigation working group, Young is helping to develop two additional initiatives, based in part on research within NASA's System-Wide Safety project. At the meeting, updates on each of these safety enhancements were provided, which are aimed at reducing risk associated with future UAS operations. Also presented at the meeting was a review of recent UAS-related accidents presented by the National Transportation Safety Board, and the status of policy and regulatory activities by the FAA, such as the "RemoteID" notice of proposed rulemaking.

Researcher Delivers Reference Implementation to Aviation Standards Group

POC: [AARON DUTLE](#), [CÉSAR MUÑOZ](#), [LAURA TITOLO](#), AND [MARIANO MOSCATO](#)

From January 24-31, researcher Aaron Dutle from NASA's Langley Research Center in Virginia delivered the NASA-developed formally verified reference implementation of the Compact Position Reporting (CPR)

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algorithm, a critical aspect of the Automatic Dependent Surveillance-Broadcast (ADS-B) system, at the 14th meeting of the Combined Surveillance Committee (CSC) held in Melbourne, Florida. The CSC is a joint committee between the RTCA special committees 186 and 209 and the European Aviation Safety Agency working groups 49 and 51, with participation from industry partners. The CSC is currently updating the Minimum Operational Performance Standards for the 1090 MHz extended squitter (DO-260 in the United States), which defines the standard for ADS-B. The CPR algorithm was developed and verified by the Formal Methods group at Langley. This delivery is the culmination of nearly five years of work performed by the Formal Methods group, under the System-Wide Safety project, in support of the CSC. The CPR algorithm specifies how aircraft communicate their current position over the ADS-B interface. The CPR algorithm is known to be difficult to implement, and errors can lead to wildly incorrect position reports. Following a formal analysis of the algorithm, the Formal Methods group proposed the following to the CSC: (1) stricter requirements, which are proved to guarantee correct behavior of CPR; (2) alternate mathematical formulas, which are equivalent to the original ones but incur fewer numerical errors; (3) alternate

formulations of the algorithm, which are formally verified correct assuming real arithmetic; (4) a reference implementation in C, which is formally verified correct, and is publicly available under NASA's Open Source Agreement; and (5) new test cases, which stress some difficult aspects of the algorithm. These recommendations were adopted and are intended to be incorporated in revision C of DO-260, which is slated to enter a final review and comment period in March 2020.

Alwyn Goodloe Attended the 2nd Assured Autonomy Workshop

POC: [ALWYN E. GOODLOE](#), [TERRY MORRIS](#), [JOHN KOELLING](#), AND [MISTY D. DAVIES](#)

On February 2, researcher Alwyn Goodloe from NASA's Langley Research Center in Virginia attended the 2nd Assured Autonomy Workshop in Phoenix. The workshop was organized by the Computing Community Consortium on behalf of the National Science Foundation. Goodloe attended various panel sessions related to artificial intelligence, verification, security, and human interaction. The issues raised at the workshop included: (1) autonomous systems must be secure with respect to a well-thought-out threat model, however there is no knowledge of a case study with a good threat model; (2) autonomous

systems must be safe with respect to a well-thought-out safety analysis, however there is no known case study for which any safety analysis has been done, and most academic researchers have no idea what such an analysis would look like; (3) verification of perception will require an unknown amount of basic research or involve new techniques that are more reliable than neural nets; (4) researchers are selecting properties to verify that they know how to formalize, however, no one believes that assuring these properties gets the community anywhere near the goal of assured autonomy (a worry is that the community is building tools focused on verifying too narrow a range of properties); (5) machine learning might make it cheaper to build a controller, but it is almost impossible to find anyone who thinks it is a good idea to put such things in safety-critical systems such as flight controls (in fact, for most robots it will be far cheaper and easier to build and verify traditional proportional integral derivative controllers); and (6) perception is the domain where the case for using machine learning is most compelling and here the verification challenge seems most intractable. Goodloe reported that the research community wants more investment in an open set of case studies of increasing complexity and criticality where the challenge problems come with the following: (1) a concept of

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operations that includes defining what environment the system is to be assured to work in; (2) a threat model defining what threats must be mitigated; (3) hazard analysis/fault model of what hazards must be mitigated and faults tolerated; and (4) a challenging goal as to what it means for the system to be “assured” in the proposed operating context.

ATD-2 Field Demonstration Partner Visit to Charlotte International Airport

POC: [BOB STAUDENMEIER](#) AND [PETE SLATTERY](#)

From February 10-11, NASA’s Air Traffic Demonstration-2 (ATD-2) team visited field demonstration partners at Charlotte Douglas International Airport (CLT). The purpose of the visit was to observe and assess how the system has

been performing since metering has been turned on for all banks of flights at CLT since February 1, 2020. Initial feedback from the FAA and airline participants at CLT describe a positive effect on managing traffic on the surface at CLT, as well as the surrounding Terminal Radar Approach Control (TRACON) airspace. During periods of highly irregular operations, such as during recent severe weather events that affected flights along the eastern half of the country, ATD-2 users retained the option to temporarily suspend metering. The ATD-2 team also met with the new American Airlines manager for air traffic operations for the southeast, who was given a tour of the Traffic Management Units at CLT tower and TRACON to gain a more comprehensive

understanding of how the ATD-2 system affects and improves traffic flow at CLT. The group also toured the new CLT tower to observe the progress being made toward the expected commissioning of the new tower on June 21.

ATM-X and Uber Working to Extend Urban Air Mobility Research Collaboration

POC: [SAVITA VERMA](#) AND [WILLIAM CHAN](#)

The Air Traffic Management-eXploration (ATM-X) project is working with Uber to create another annex to continue the joint Urban Air Mobility (UAM) airspace integration research that is currently covered under a multi-year Space Act Agreement with Uber Inc., created in 2018. Annex One was used to conduct collaborative research studies on integrating UAM operations with existing air traffic operations in both controlled and uncontrolled airspace. The efforts under that annex included the X-1 part-task studies to investigate methods of managing high-density UAM operations in today’s airspace. Another activity under that annex was the X-2 engineering evaluations which extended the air traffic management paradigm and system reference implementation developed for the Unmanned Aircraft System Traffic Management Technology Capability Level 4 aircraft to UAM operations.



Scott Pressley, American Airlines southeastern air traffic manager; Mike Hoprich, CLT National Air Traffic Controllers Association ATD-2 point of contact; and Bob Staudenmeier, Cavan Solutions, NASA Support

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The collaboration between NASA and Uber has resulted in important lessons learned and insights that have been, and continue to be, documented for the benefit of the UAM community at large. Given the high technical value and research impact of the collaborations between NASA and Uber, the two organizations are pursuing this follow-on annex under the same Space Act Agreement to continue these research collaborations to accelerate airspace access and integration of UAM into the National Airspace System.

Integrated Demand Management Workshop

POC: [NANCY SMITH](#) AND [PAUL LEE](#)

The Air Traffic Management-eXploration (ATM-X) project's Integrated Demand Management (IDM) research team held a three-day workshop at NASA's Ames Research Center in California, from February 11-13. The purpose of the workshop was to offer a final opportunity for traffic flow management experts to provide feedback before NASA delivers the IDM concept and supporting documentation to FAA AJV-S1. The FAA tasked the team to explore ways to bring near-term applications of IDM into current day operations. Participants thought that IDM provided a good



Discussions and demonstration of the Integrated Demand Management concept

pathway to implementing Initial Trajectory-Based Operations into the National Airspace System and agreed that IDM provided a step toward implementing the Initial Trajectory-Based Operations vision. Day one and day two participants included the co-leads of the FAA's Time-Based Flow Management operations team, the National Air Traffic Controllers Association representative to the FAA's Program Management Office, and representatives from the FAA's Air Traffic Control Systems Command Center, providing a perspective from the FAA's Traffic Flow Management System. On day three, the Collaborative Decision Making (CDM) Steering Group industry co-chair from Alaska Airlines, along with the CDM FAA co-lead, and airline representatives from United, Southwest, and JetBlue, were briefed on IDM, and observed a lab demonstration of the concept. Representatives from MITRE Center for Advanced



Aviation System Development also attended the workshop.

ATD-2 Briefing at National Customer Forum

POC: [SHAWN ENGELLAND](#) AND [AL CAPPS](#)

On February 12, NASA's Air Traffic Demonstration-2 (ATD-2) team was invited to speak at the National Customer Forum held at the FAA David J. Hurley Air Traffic Control System Command Center in Warrenton, Virginia. The audience included representatives from the major U.S. passenger and cargo airlines, general aviation, FAA, and National Air Traffic Controllers Association. The NASA team presented an overview of the ATD-2 concept and benefits, Phase 3 Field demo status, and ATD-2 to Terminal Flight Data Manager (TFDM) transition plans. The meeting agenda had an emphasis on metrics and provided perspectives on stakeholder needs and improvements. The audience

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expressed their appreciation for the ATD-2 system and its influence on the TFDM program and look forward to continued collaboration and engagement.

National Campaign/FAA Airspace Assumptions Workshop

POC: [SHIVANJLI SHARMA](#)

The National Campaign project hosted FAA representatives from the Air Traffic, Flight Standards, and Aircraft Certification organizations at NASA's Ames Research Center in California, from February 13-14. The purpose of the meeting was to discuss scenarios and airspace assumptions for the National Campaign Development Test flight demonstrations and simulations. The National Campaign Development Test is the first activity in a series with vehicle and airspace industry partners focused on establishing the certification requirements and standards needed for the Urban Air Mobility (UAM) market to move forward. The scenarios define a series of progressively more complex capabilities that will demonstrate increasingly integrated operations across infrastructure, vehicle, and airspace components. NASA's National Campaign leadership, the National Campaign Airspace Test Infrastructure team, FAA partners, and Air Traffic Management-eXploration project researchers

collaborated on defining the key assumptions for UAM airspace integration. The groups discussed the need for both airspace and performance authorizations as well as the respective roles and responsibilities of the UAM operators, air navigation service providers, and pilots, along with the other entities involved in UAM operations. In addition, the National Campaign Development Test scenarios were discussed in detail across both flight and simulation activities to gain concurrence on interactions and modes of communication in both uncontrolled and controlled airspace scenarios. The groups intend to collectively generate an assumptions document that will be shared between NASA and the FAA.

NASA-FAA Urban Air Mobility/Unmanned Aircraft System Research Review

POC: [WILLIAM N. CHAN](#)

On February 19, NASA and the FAA held a research roundtable at the National Institute of Aerospace near NASA's Langley Research Center in Virginia. The purpose of the roundtable was to present current research efforts across both organizations around Urban Air Mobility (UAM) topics, including Unmanned Aircraft System (UAS), to identify potential areas of collaboration. The agenda included FAA updates of their UAS research

strategy, UAS Traffic Management concept of operations, and UAM initiatives. NASA provided descriptions of the Advanced Air Mobility activity, the UAM Mission Office, ATM-X project, the UAS in the National Airspace System project, the Revolutionary Vertical Lift Technology project, System-Wide Safety project, and the X-57. As a follow-on action, NASA and the FAA will share specific areas of research to focus our collaborations. FAA attendees included Sabrina Saunders-Hodge, Paul Strande, and Wes Ryan.

Joint Surface Collaborative Decision Making Team and Flow Evaluation Team Meeting at NTX

POC: [GREG JUR0](#)

On February 20, NASA's Air Traffic Demonstration-2 (ATD-2) team hosted a joint meeting of the FAA's Joint Surface Collaborative Decision Making Team (SCT) and Flow Evaluation Team (FET) groups at the North Texas (NTX) Laboratory in Dallas. Both groups are comprised of FAA and industry members. There were multiple FAA organizations and six airline companies represented at the meeting. ATD-2 representatives provided a detailed presentation on the real-time metrics that are being developed for use during the Stormy 2020 Trajectory Options Set (TOS) testing, scheduled to begin

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Stakeholders participating at NTX meeting

in early April. During the meeting, NASA representatives took the opportunity to provide hands-on demonstrations of the ATD-2 tool to each participant. The primary focus of the demonstrations was to aid in a thorough understanding of Phase 3 capabilities. Each of the demonstrations included multiple examples of outlining the process of a candidate flight being identified and subsequently submitted for a reroute by the flight operator and approved by air traffic control. The presentations included a briefing on the progress that has been made on integrating National Airspace System-wide restrictions as a means of presenting relevant candidate flights for the flight

operators. An overview was also provided of potential future work in this area and an FET member presentation on requirements that would be needed to ensure the successful, continued use of TOS technology and procedures. The briefing on future requirements for industry and FAA relied heavily on many of the lessons learned so far during the ATD-2 Stormy 2019 test, as well as previous NASA ATD-2 work at Charlotte Douglas International Airport. At the meeting, participants provided positive feedback on the value of the presentations and discussion, and the briefing generated active discussion. Most notably, the feedback received regarding the value of integrating the use of real-time metrics during Stormy 2020 was overwhelmingly positive. All the participants expressed that these real-time metrics will provide the flight operator with critical new information to enable more precise and expeditious decision making. Moreover, both the SCT and FET

groups expressed their appreciation to the NASA representatives for the many lessons learned during the ongoing ATD-2 work and their desire for NASA to continue making positive enhancements to the National Airspace System. The NASA team will continue to participate in the regularly scheduled SCT and FET meetings.

ATD-2 Training at Atlanta Air Route Traffic Control Center

POC: [PETE SLATTERY](#) AND [BOB STAUDENMEIER](#)

From February 25-26, the NASA Air Traffic Demonstration-2 (ATD-2) team visited the Atlanta Air Route Traffic Control Center (ZTL ARTCC) in Hampton, Georgia. The purpose of the visit was to train new traffic management coordinators (TMCs) and surface TMCs on the ATD-2 system. Refresher training was provided to all TMCs on new features that have been incorporated into the system over the last several releases. All TMCs were briefed

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Bob Staudenmeier and Mark Ellerbee (ZTL TMU)

on both the capabilities of ATD-2's Ramp Traffic Console (RTC) and the Surface Trajectory Based Operations (STBO) Client. During each session, TMCs were guided through interactions with the RTC and STBO Client interfaces and introduced to features and data exchange between the two tools. Also discussed was how ATD-2 is integrated into their Time-Based Flow Management system through the Integrated Departure Arrival Capability and the non-verbal interaction that is available through electronic negotiations. TMCs had the opportunity to provide feedback and discussed how it could be usable in the ZTL environment. TMCs were also introduced to the concept of "pre-scheduling" and discussions ensued about how well that has been working with Hartsfield-Jackson Atlanta International Airport and O'Hare International

Airport flights. Outcomes of the training, beyond proficiency on the ATD-2 systems, included increased use of the tool, especially during severe weather conditions.

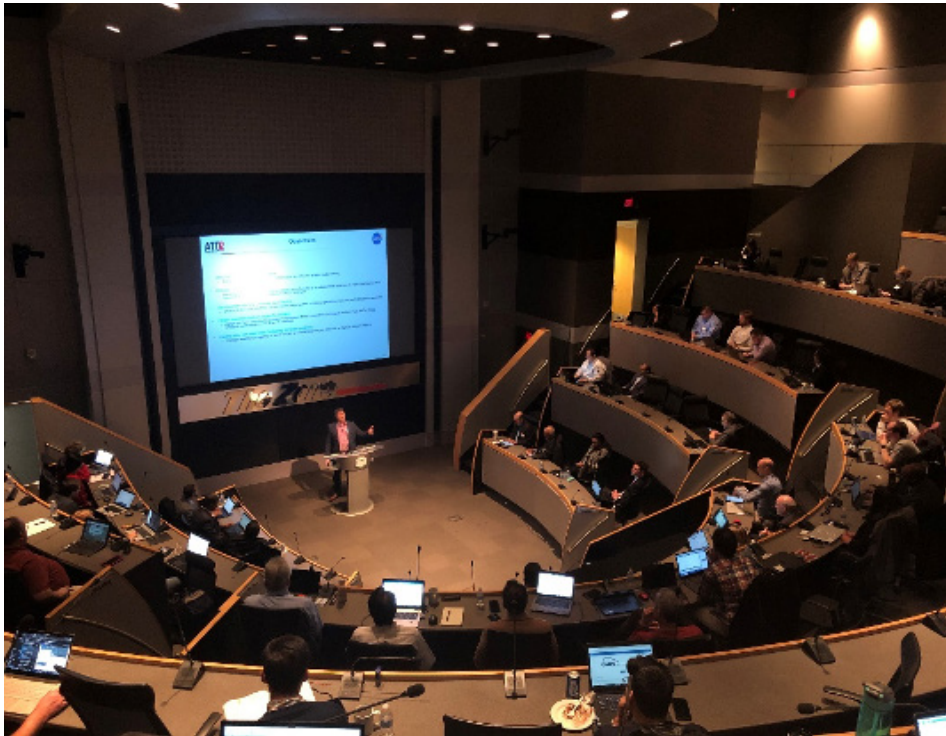
Machine Learning as a Service – Briefing to SWIM Industry-FAA Team Forum

POC: [AL CAPPIS](#)

On February 26, the NASA ATD-2 team briefed the System Wide Information Management (SWIM) Industry-FAA Team (SWIFT) in Memphis, Tennessee. The forum was held at the FedEx Institute of Technology on the University of Memphis campus and was attended by approximately 200 participants from all the major airline operator groups and aviation solution providers (see member list image below). The presentation provided two specific

examples of machine learning solutions developed by applying a data mining problem solving workflow to aviation challenges. The workflow NASA used is loosely based on the cross industry standard process for data mining, which has been used successfully in other industries. The first example demonstrated a gradient boost classifier that improved arrival runway prediction classification by approximately 20 percent over the available sources in SWIM today. The presentation then described the steps that NASA performed to deploy this machine learning model to a web service using commonly available open source technology. The second example demonstrated a gradient boost regressor that estimates the size of tactical delay impact into a busy airspace resource in the Northeast Corridor. This example responds to a top need identified by the SWIFT analytics team at their first meeting in January 2020. The data and visualization from this learner generated significant feedback from the meeting participants. The presentation emphasized the importance of frequent engagement between analysts and operational users in the SWIFT community. Additionally, the presentation highlighted the need to describe aviation operations challenges into data science formats so that the aviation industry can benefit from this significant new technology.

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SWIFT Forum: University of Memphis

NASA Ames Hosts Congressional Staffers

POC: [RON JOHNSON](#)

On February 26, a tour and demonstration of the Unmanned Aircraft System Traffic Management (UTM) Autonomous Operating Systems Laboratory was provided to a delegation of congressional staffers at NASA's Ames Research Center in California. The tour was conducted by Joseph Rios and Jeffrey Homola from the UTM project team. The delegation included ten congressional staffers accompanied by two members of FMC (Former Members of Congress), an association of former staffers. The staffers represented a bi-partisan cross section of congressional districts from across the United States, including California, Florida, Indiana, Ohio, Michigan, North Carolina, Texas, and Washington.

ATM-X Hosts the FAA's Air Traffic Mission Support Services Strategy Directorate

POC: [BRYAN BARMORE](#)

On March 3, the Air Traffic Management-eXploration (ATM-X) project team hosted visitors from the FAA's Air Traffic Mission Support Services Strategy Directorate for a technical exchange on traffic flow management at NASA's Langley Research Center in Virginia. The FAA visitors included Guillermo Sotelo, Jim Wetherly,

List of SWIFT stakeholders as briefed in SWIFT forum on February 26, 2020

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Kerry Capes, and Brian Bagstad, who are exploring the impacts of new entrants to the airspace on traffic flow management and leveraging flight deck capabilities. NASA demonstrations were provided by Langley researchers David Wing for the Traffic Aware Strategic Aircrew Request tool, Matt Underwood for the Strategic Airborne Trajectory Management tool, and Nelson Guerreiro for the Urban Air Mobility (UAM) mission planner. Heather Arneson from NASA's Ames Research Center in California demonstrated the UAM network scheduler. The FAA saw several concepts they thought aligned with their goals, and a follow-on meeting will be planned in May following the ATM-X Key Decision Point-Continuation Assessment, and the release of a draft roadmap by the FAA.

Aerobahn Terminal Flight Data Manager Planning Workshop

POC: [YOON JUNG](#) AND [HANBONG LEE](#)

On March 4, Airspace Technology Demonstration-2 (ATD-2) researchers participated in the Aerobahn Terminal Flight Data Manager (TFDM) Planning Workshop, which was hosted by Saab Sensis Corporation in Syracuse, New York. The goal of the workshop was to bring future TFDM users identified by the FAA's early TFDM implementation



Participants at Saab Sensis, Syracuse, New York

waterfall, including major airlines (American, United, Delta, and Southwest) and airports (Charlotte, San Francisco, Seattle, and New York), updates on the user tool and solicit feedback. Currently, Saab Sensis is developing a tool powered by their Aerobahn product to provide users with an interface to communicate with TFDM. The interface includes submitting an airline's earliest off-block times and substitution requests for surface metering programs, and display of target off-block times and target movement area entry times generated by TFDM. Workshop participants

discussed TFDM functionality to be used as well as roles and responsibilities during a surface metering program to prepare for the implementation of the program at their sites. ATD-2, a precursor to TFDM, is currently under operational evaluation at Charlotte Douglas International Airport facilities, including the FAA air traffic control tower and American Airlines ramp tower since September 2017. ATD-2 researchers shared experiences and lessons learned from the field demonstration. The next workshop, scheduled in June, will be hosted by the Port Authority of New York and New Jersey.

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Flight Management System (FMS) Predicted Meter Fix Estimated Time of Arrival (ETA) by TAM



- * Meter fix delay is set by TAM operator relative to aircraft's nominal ETA at the fix.
- * Nominal ETA at meter fix is based on a trajectory prediction along the nominal flight route.
- * Scheduled time of arrival at meter fix $STA_{MF} = ETA_{MF} + \text{delay}$
- * ETA_{MF} can come from either FMS or internal TAM trajectory prediction (currently the latter).

Example of Tailored Arrival Manager delay request

ecoDemonstrator Lab Series Completed

POC: [WILLIAM CHAN](#)

NASA's ecoDemonstrator and testbed teams successfully completed the fourth Tailored Arrival Manager (TAM) "Lab Shot" series with the FAA and Boeing. The first part was completed on February 20, while the second part was completed on March 4. This was the first time that all critical-path system data exchanges for TAM were tested including Automatic Dependent Surveillance – Contract (ADS-C) and Controller Pilot Data Link Communications (CPDLC). This required TAM operations in the testbed lab at NASA's Ames Research Center in California, with advisories triggered by manual delay settings. TAM uses ADS-C data from Boeing to develop an efficient

conflict-free resolution to meet a time delay. This resolution was sent to the FAA, who automatically generated a CPDLC message which was sent from the FAA to a Boeing aircraft test bench. Several scenarios were successfully run to test the TAM resolution development and loading in the test bench.

NASA Langley Hosts Testing to Evaluate GPS Backup Technologies

POC: [STEVE YOUNG](#), [EVAN DILL](#), [JOHN KOELLING](#), AND [MISTY D. DAVIES](#)

An interagency agreement was initiated at NASA's Langley Research Center in Virginia, between the Department of Transportation and Langley to test, evaluate, and demonstrate Alternative Positioning, Navigation and Timing (APNT) systems as requested through the

National Defense Authorization Act for fiscal year 2018. The congressional request seeks information regarding the efficacy of current APNT systems that may be used as a backup or complement to the Global Positioning System (GPS). Langley was selected as the test site for six such systems. Langley hosted several months of testing in which over 50 personnel from NASA, Department of Transportation, MITRE, Zeta, and APNT vendors participated in a predefined set of trials. Testing culminated with a briefing and demonstration at Langley on March 13. In attendance were congressional staffers, members of the National Space-Based Positioning, Navigation and Timing Advisory Board, as well as officials from the Joint Chiefs of Staff, Department of Homeland Security, Department of Defense,

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APNT Advisory Board and government agency representatives at Langley

Department of Energy, Department of the Interior, Department of Transportation, National Oceanic and Atmospheric Administration, National Institute of Standards and Technology, FAA, and NASA. Subsequently, results obtained in these experiments will be used as part of a final report to Congress regarding potential backup systems for GPS and next steps. In February, the president signed an executive order issuing a national directive to make the United States more resilient to GPS outages. This testing is a precursor to being able to deliver on the order.

<https://www.whitehouse.gov/presidential-actions/executive-order-strengthening-national-resilience-responsible-use-positioning-navigation-timing-services/>

Additionally, this activity was featured in a recent GPS World article:

<https://www.gpsworld.com/dot-holds-first-gps-backup-technology-demonstration/>

NASA/ATD-2 Phase 3 Stormy Kickoff Meeting

POC: [GREG JURO](#)

On March 19, the Airspace Technology Demonstration-2 (ATD-2) project team conducted a Stormy 2020 kickoff meeting with the field operators in the North Texas area. The meeting was conducted with all participants remotely due to COVID-19 social distancing practices. The purpose of the meeting was to determine the readiness level of the field users to begin the test in early April as well as provide updates on the new features available in the

system. The field users unanimously agreed to start the testing on April 6. Due to COVID-19, there may be periods when the flight operators or the FAA facilities are not able to participate due to staffing or other variables associated with COVID-19. Despite this, all field users were enthusiastic about participating in the test beginning April 6. The updates on new features focused on a demonstration of the real-time metrics and enhanced filtering capabilities now available in the ATD-2 system. These new features were in response to valuable field user input received as the result of the testing conducted in the summer of 2019. The real time metrics include aggregate delay savings in several categories that are meaningful to the airlines and FAA facilities, as well as a self-scoring metric that reflects the accuracy of the ATD-2 system's predictions. The enhanced filtering capabilities now include the capability to integrate National Airspace System-wide reroute restrictions which will enable the system to present a more precise list of candidate flights to the flight operators. The NASA team is adjusting the training process to accomplish the training remotely instead of physically being onsite. These adjustments include providing the training via video conferencing, video recordings, and slideshow presentations.

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

Urban Air Mobility System Requirements Review Completed

POC: [ANNIE CHENG](#)

NASA's Air Traffic Management-eXploration (ATM-X) project's initial Urban Air Mobility (UAM) subproject conducted a system requirements review (SRR) for its upcoming UAM X-3 airspace simulation for NASA's National Campaign-1, formerly the Grand Challenge, in two sessions, on March 6 and March 20. The objective of the SRR was to assess whether X-3, as proposed, will result in successful execution to prepare for future National Campaign simulations and flight activities, particularly National Campaign-1. The SRR sessions were formal opportunities for an independent NASA review panel and internal stakeholders to provide valuable feedback and recommendations to the UAM team to ensure that the X-3 simulation planned for September 2020 is well-aligned with the goals and objectives of UAM and ATM-X, as well as those for the Advanced Air Mobility project and its National Campaign subproject.

Testbed Training Completed for NASA Ames and Langley Staff

POC: [KEE PALOPO](#)

From March 19-20, the testbed training team conducted the remaining two of the three testbed

training sessions planned for March 2020, which included 16 internal NASA personnel from NASA's Ames Research Center in California and NASA's Langley Research Center in Virginia. The sessions were conducted using Microsoft Teams online and were attended by ecoDemonstrator and Urban Air Mobility developers, as well as information technology personnel. Despite some minor glitches, mainly due to the Microsoft Teams configuration and user interface navigation issues, the participants were able to successfully complete the training using self-guided-and-pacing training slide material. The online training experience could serve as a future training model as part of the current testbed transition planning.

Effectiveness of Alternate Concepts to Contemporary Development Assurance Processes

POC: [TERRY MORRIS](#), [PAUL MINER](#) AND [MISTY D. DAVIES](#)

The final presentation of the Basic and Applied Aerospace Research and Technology contract, "Effectiveness of Alternate Concepts to Contemporary Development Assurance Processes," was briefed virtually on March 25. The presenters included Eric M. Peterson, Electron International II, Inc.; Michael DeVore and Jared Cooper, Barron Associates, Inc.; and Greg Carr, Architecture Technology Corporation in collaboration with

Jacek Kawecki, Uber Elevate. NASA and the FAA solicited industry research to identify and evaluate novel or alternate concepts for assuring safety of airborne systems. Using a baseline of existing industry-standard approaches to system safety assurance, this research explores alternate concepts and evaluates their effectiveness against current industry practices. The presenters focused on real-time assurance (RTA) and revealed that: (1) RTA alternate assurance concept provides equivalent implementation assurance to current industry practices; (2) RTA is an architectural solution which isolates and monitors low confidence implementations to mitigate errors or implementation mistakes; (3) RTA safety boundary creation and implementation is key to achieving certification assurance criteria; and (4) in a provided example, there are solidified RTA advantages for a) initial certification assurance activity reductions, b) ability to certificate non-deterministic or other current problematic implementation strategies, and c) substantial activity reduction potential during update and/or revision certification processes.

UAM Regional Modeling Collaboration with Los Angeles Department of Transportation

POC: [KAPIL SHETH](#) AND [PARIMAL KOPARDEKAR](#)

NASA is exploring collaboration opportunities with the Los Angeles

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Department of Transportation (LA DOT) focused on planning for Urban Air Mobility (UAM) as a transportation alternative in Los Angeles. As a part of the UAM infrastructure development, LA DOT – like a growing number of city governments – desire a capability to assess better prospective UAM vertiport locations. NASA is developing a Regional Modeling UAM Planning Tool to address this need. On March 27, a virtual meeting was held with a representative from the Los Angeles mayor's office, the general manager and members of the LA DOT, some members of their contract support personnel, and the NASA Regional Modeling team. After discussing the current priorities, three presentations were made. First, NASA described its vision for the vertiport location assessment tool, where various factors like environmental impact, multi-modal transportation options,

zoning, etc., are incorporated into the decision-making process. Then, the Los Angeles mayor's office representative presented their path forward and how UAM is being pursued as an essential option going forward. Lastly, an LA DOT support person presented their thought process for vertiport selection. This was the first meeting between NASA and LA DOT to explore research collaboration, and it was decided that additional meetings would be mutually beneficial to further develop potential points of collaboration. LA DOT will take the initiative to invite NASA for further meetings.

Testbed Overview Presented to the FAA, MITRE, and MIT Lincoln Lab

POC: [KEE PALOPO](#)

An overview of NASA's testbed was presented to the Time-

based Management Performance Assessment Team on March 27, via WebEx, during their bi-weekly meeting. Attendees consisted of the following organizations: NASA, the William J. Hughes FAA Technical Center, MITRE, and MIT Lincoln Laboratory. The presentation material consisted of the envisioned testbed, its state of implementation to date, and how the community could leverage each other's facilities and tools for a common experiment. After the presentation, a representative from MIT Lincoln Laboratory requested information about the process for connecting to the testbed.

RECOGNITION

Mallory Graydon Presents KRAMPUS Results at AIAA SciTech 2020

POC: [MALLORY GRAYDON](#),
[TERRY MORRIS](#) AND [JOHN KOELLING](#)

On January 6, Mallory Graydon presented a paper entitled “Guidance for Designing Safety into Urban Air Mobility: Hazard Analysis Techniques” at the American Institute of Aeronautics and Astronautics SciTech 2020 Conference in Orlando, Florida. Graydon presented the first public, referenceable release of results from the KRAMPUS project aimed at new entrants into the Urban Air Mobility (UAM) space. The paper presented examples from a preliminary hazard analysis of a specimen Unmanned Aircraft System concept, illustrating such analyses and explaining their importance. Graydon also attended several talks on digital avionics, human factors, air traffic management, security, modeling and simulation, and climate change. She also met with colleagues who are performing research of interest to NASA, including Dan Newman, Boeing, who is also performing hazard analyses on concept UAM vehicles.

Husni Idris Named Associate Fellow of the AIAA

POC: [TODD FARLEY](#)

NASA researcher Husni Idris was named an Associate Fellow of the



John Langford, President of AIAA, formally recognizes Husni Idris as an Associate Fellow

American Institute of Aeronautics and Astronautics (AIAA) at a gala event in Washington, DC, on January 8. The AIAA reserves this distinction for “persons who have done original work of outstanding merit, or who have otherwise made outstanding contributions to the arts, sciences, or technology of aeronautics or astronautics.” Idris’ contributions are well-known throughout the international community, where he is regarded among the leading minds in air traffic management research. His 25-year career spans contributions as a researcher in academia, industry, and government, from the Artificial Intelligence Lab at the Massachusetts Institute of Technology (MIT) to senior air traffic researcher at Engility Corporation, to his work at NASA’s

Ames Research Center in California. He has published more than 40 technical articles in peer-reviewed and conference literature. His most recent publication, “Accrued Delay Application in Trajectory-Based Operations,” was distinguished as best-in-track at the prestigious 2019 USA/Europe Air Traffic Management (ATM) Research & Development Seminar in Vienna, Austria. Idris currently leads a team that is researching Collective Autonomous Behavior in ATM under NASA’s Transformative Tools and Technologies project, and he is a member of the agency’s Autonomous Systems Capability Leadership team. He is the associate editor of the “AIAA Journal of Air Transportation” and the “Transactions of the Japan Society for Aeronautical and Space Sciences.”

RECOGNITION

Finalist-Collier Trophy Award

POC: [RON JOHNSON](#)

On January 19, the Unmanned Aircraft System Traffic Management (UTM) team was named one of nine finalists for the 2019 Robert J. Collier Trophy Award. The UTM team was nominated by the NASA administrator and the team is comprised of NASA, FAA, and industry partners that were instrumental to the development and testing of the UTM system. The UTM team will give a presentation to the selection committee next quarter, and the winner will be announced sometime afterwards. The Collier Trophy Award, begun in 1910, is awarded annually by the National Aeronautic Association for “the greatest achievement in aeronautics or astronautics in America, with respect to improving the performance, efficiency, and safety of air or space vehicles, the value of which has been thoroughly demonstrated by actual use during the preceding year.” The list of Collier winners represents a timeline of aviation, as many of the awardees mark major events in the history of flight.

Applied Machine Learning Days Conference

POC: [NIKUNJ OZA](#)

Nikunj Oza presented a paper, “Machine Learning for Aviation Safety at NASA,” at the Artificial

Intelligence and Aviation track within the Applied Machine Learning Days Conference at Ecublens, Switzerland, from January 26-28. Oza was invited by Chrysanthi Tsimetri, data team point of contact at Swiss Air Lines.

NASA Sustainable Aerospace Supply Chain and Manufacturing Workshop

POC: [PARIMAL KOPARDEKAR](#)

From February 4-5, more than 200 people attended the NASA Sustainable Aerospace Supply Chain and Manufacturing Workshop at the Ames Conference Center of NASA’s Ames Research Center in California. The workshop was organized by the NASA Aeronautics Research Institute



Parimal Kopardekar, NASA Aeronautics Research Institute director, at the NASA Sustainable Aerospace Supply Chain and Manufacturing Workshop

and brought together industry leaders and stakeholders to discuss a national strategy that will work to enable a sustainable aerospace supply chain and manufacturing network. The input collected over the two-day workshop will be curated into a white paper and shared with the ecosystem for help to enable the necessary capabilities going forward.

Airport Planning Design and Construction Symposium

POC: [MIN XUE](#)

On February 20, Min Xue participated as a panelist on the topic, “New Types of Flying Vehicles,” at the Airports Consultants Council/American Association of Airport Executives (ACC/AAAE) Airport Planning Symposium in Reno, Nevada. There were about 1,400 attendees at the panel session. New vehicle discussion topics included automation, certification, safety, noise, and aircraft operation procedures. There was also a discussion around U.S. leadership in Urban Air Mobility (UAM)/Unmanned Aircraft System Traffic Management (UTM) research and development. The need for, and value of, NASA’s UAM National Campaign and UAM/UTM research were clear throughout the conversation. The panel discussion was well-received, and positive feedback was received through several channels after the meeting. Xue is a member of the initial UAM

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subproject team within the Air Traffic Management-eXploration project. The panel was hosted by Justin Guan and Byron Thurber (Arup's San Francisco Integrated Planning Group). Other panelists included Danielle Rinsler, Uber; Justin Towles, AkinGump; and Jasenka Rakas, UC Berkeley.

UTM Named Finalist in World Air Traffic Management Congress Maverick Awards

POC: [RON JOHNSON](#)

World Air Traffic Management Congress 2020, scheduled from

March 9-11 in Madrid, Spain, was canceled due to travel restrictions from COVID-19. On March 23, however, the Inaugural Maverick Awards winners were announced virtually by the Air Traffic and Control Association and Civil Air Navigation Services Organization. NASA's Unmanned Aircraft System Traffic Management (UTM) was named one of three finalists, out of a highly competitive group of 45 nominations in the innovation category which "recognizes new ideas, technologies, and concepts that challenge current air traffic management norms with the

potential to significantly advance performance, operations, or capabilities." UTM was named "for its successful, simultaneous flight of multiple small unmanned aircraft systems (UAS) in a complex urban environment using the UAS Traffic Management (UTM) system."

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