



AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

OCT-DEC 2017 | Quarter 1



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Underway

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AOSP IN THE NEWS

[Commercial UAS Industry Gathers at Drone World Expo](#)

Aviation International News (10/04) reports that Dr. Parimal Kopardekar, NASA Manager of the Safe Autonomous Systems Operation project, reassured the audience that the U.S. government is trying to help the commercial drone industry. “We’re trying to make sure your businesses flourish by giving you access to airspace and interoperability with other operators,” he said.

[NASA, NUAIR Partner to Grow Central New York Drone Industry](#)

Business Facilities Magazine (10/04) reports that NASA and the Northeast UAS Airspace Integration Research Alliance (NUAIR) have formed a groundbreaking agreement to grow the drone industry in Central New York and the Mohawk Valley. The agreement formalizes a partnership in support of two elements of the state’s UAS strategy: the launch of the world’s first 50-mile UTM Corridor and creation of NUSTAR, the most comprehensive UAS test facility in the nation.

[State Advances Drone Industry with Planned Testing Corridor in Rome, N.Y.](#)

The Daily Freeman (10/22) reports that companies will be able to use the corridor to test hardware in airspace and where manned aircraft also fly. Part of the concept is to help NASA to test technology that will allow the FAA to create regulation opening the national airspace to commercial drone industry.

[NASA, Boeing Partner to Conduct Flight Safety Research with Synthetic Vision Tech](#)

ExecutiveBiz (11/02) reports Boeing and NASA have entered into a Space Act Agreement to study pilot awareness and response to unplanned situations as part of efforts to help improve aviation safety and flight training.

[NASA Creates Industry Day to Talk Drone/NAS Integration with Academia, Industry](#)

Aviation Today (11/03) reports NASA is further calling on the industry to help with unmanned aircraft system (UAS) integration into the U.S. NAS. The agency is hosting an industry day at the end of the month to galvanize interested parties in preparation of a 2020 demonstration under its “UAS in the NAS” project.

[NASA Holding UAS Industry Day on November 30](#)

Unmanned Aerial (11/03) reports the purpose of NASA’s Industry Day is to gather input from commercial and academic partners who have an interest in or have technologies available that can support NASA’s projects that work in lockstep with the FAA to address the challenges facing UAS integration.

AOSP IN THE NEWS

[NASA and Boeing Partner to Test Synthetic Vision Systems](#)

Aerospace Technology (11/06) reports NASA has collaborated with Boeing to test and certify synthetic vision systems as part of a research program that aims to enhance flight training and aviation safety.

[Reaping the Benefits of Safe Drone Technology](#)

The Hill (11/06) reports UAS technology, or Drones, has evolved much the same as computers, which went from room-sized machines operated by NASA to laptops and then smart phones carried around in our pockets.

[Boeing, NASA to Test NextGen Synthetic Vision in 787 Sims](#)

Aviation Today (12/18) reports NASA research technical lead Kyle Ellis hopes the collaboration with Boeing and other industry partners will help identify what makes up a best synthetic vision system for attitude state awareness for all pilots – not just seasoned veterans.

[NASA, FAA Partner to Upgrade Air Traffic Control](#)

KJZZ (12/26) reports that “NASA brings some sort of scheduling capability and tools and interfaces it to the existing systems, and on to the controller and flight crews in order for them to conform to those schedules,” said NASA project manager Leighton Quon. NASA projects a 40 percent reduction in departure delays at congested airports like Sky Harbor, where tower controllers already use FAA prototype software to track flights.

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

ATD-2 Field Demonstrations Underway

POC: [SHAWN ENGELLAND](#) AND [SHIVANJLI SHARMA](#)

The Airspace Technology Demonstration-2 (ATD-2) Phase 1 Integrated Arrival Departure Surface Operations (IADS) Baseline Demonstration commenced on September 29 and is being conducted in a series of “micro-phases.” Phase 1A was conducted in the NASA ATD-2 Lab located at Charlotte Douglas International Airport (CLT), and involved using the ATD-2 system for all data exchange features between the Federal Aviation Administration (FAA) Air Traffic Control Tower (ATCT) and the American Airlines (AAL) ramp. Running in tandem

with Phase 1A, Operational Shadow Evaluation (OSE) Session 13 was conducted to review Phase 1A, demonstrate new features of the recent software release, and discuss procedures for Phase 1B. Field Demo Partners from National Air Traffic Controllers Association, AAL, FAA Headquarters, Washington Air Route Traffic Control Center (ARTCC), and CLT ATCT participated in the OSE1 session. The NASA team reviewed current feedback received, tech support resolutions, and planned improvements in the IADS system based on user feedback. Discussions provided valuable feedback on the progress of the Phase 1 Field Demonstration, and Field Demo Partners expressed their

excitement for Phase 1B. Phase 1A was completed on October 25.

Phase 1B operations began November 1. In this micro-phase, FAA Traffic Management Coordinators (TMCs) at the CLT ATCT and Washington ARTCC used the ATD-2 system to electronically negotiate takeoff times for Call for Release (also known as Approval Request or APREQ) departures being scheduled into busy northeast corridor overhead traffic flows. The ATD-2 electronic negotiation feature builds on the Integrated Departure Arrival Capability (IDAC) in the FAA’s Time Based Flow Management (TBFM) system. In the ATD-2 implementation, the standard IDAC tower user interface is replaced by the ATD-2 IADS Surface Trajectory Based Operations (STBO) component, enabling ATCT TMCs to perform IDAC-style scheduling for APREQ flights with their primary surface tool. Additionally, the ATD-2 implementation automatically delivers predicted takeoff times from the STBO surface tool to the Washington ARTCC tool, thereby improving CLT departure demand predictions used by the TBFM scheduling system. The ATD-2 IADS system also includes user interfaces at the CLT ramp tower that provide ramp managers and controllers



Display depicting ATD-2 Phase 1B Operations.

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with information on negotiated APREQ release times and pushback advisories to meet APREQ times. This achievement represented 17 months of collaboration between the NASA ATD-2 team, multiple FAA organizations, and the TBFM contractor, to implement a secure and reliable network interface between the NASA ATD-2 IADS system at CLT and the operational FAA TBFM system at Washington ARTCC. The collaboration produced a new interface without requiring any code changes to the TBFM system, which will serve as a model for future FAA efforts to integrate TBFM with other decision support systems. The Phase 1B field demo plan called for CLT ATCT and Washington ARTCC to use the ATD-2 electronic APREQ scheduling in a semi-automatic mode, which would require the ARTCC TMC to acknowledge a negotiated release time. This process would be supplemented with a phone call—the same as manual APREQ scheduling. After an initial confidence-building period, the supplemental phone call will be dropped, and the ATD-2 system will be routinely operated in semi-automatic mode.

The goal of this was to demonstrate sufficient APREQ compliance performance for the ATD-2 system to be operated in fully-automatic mode for APREQ scheduling. Phase 1B concluded in late November.



ATD-2 Tools in Live Operations at CLT.

On November 29, ATD-2 began Phase 1C operations. In this micro-phase, FAA Traffic Management Coordinators (TMCs) at the CLT ATCT and AAL Ramp Traffic Managers and Controllers collaboratively used the ATD-2 IADS system to meter flights departing from CLT Airport. ATD-2 departure metering alleviates demand/capacity imbalances on the airport surface by advising controllers to hold some departing flights at the gate instead of having the flights wait in long departure queues at the end of the runway. Shifting some of the departure wait time from the taxiway to the gate saves fuel, reduces emissions, and gives airlines and passengers more options in the period prior to pushback. The surface departure metering capability being demonstrated at CLT is consistent with the Surface Collaborative Decision Making (CDM) concept developed by the FAA and industry over a number of years. NASA combined Surface CDM principles

with advanced trajectory-based scheduling technology to create the ATD-2 IADS system, which also features multi-facility data exchange and integration capabilities, and a departure scheduling interface with the FAA's en-route TBFM system to provide a comprehensive IADS traffic management solution. With the introduction of surface departure metering, NASA has now deployed all capabilities planned for Phase 1 of the ATD-2 Field Demonstration. FAA TMCs and AAL Ramp Traffic Managers and Controllers will use the ATD-2 IADS system in daily operations at CLT and Washington ARTCC while NASA researchers collect and analyze Phase 1 data and further develop the ATD-2 IADS system to implement capabilities for Phase 2 of the Field Demonstration, which begins in the Fall of 2018.

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Kickoff Meeting with National Test Sites

POC: [ARWA AWEISS](#)

The Technical Capability Level (TCL) 3 Testing Awards were issued to six UAS Test Sites on October 2. Following the announcement of the awards, the Unmanned Aircraft Systems (UAS) Traffic Management team held a kickoff teleconference with the UAS National Test Sites to discuss making preparations for testing. Draft test plans are due October 27, and the testing period will commence shortly thereafter.

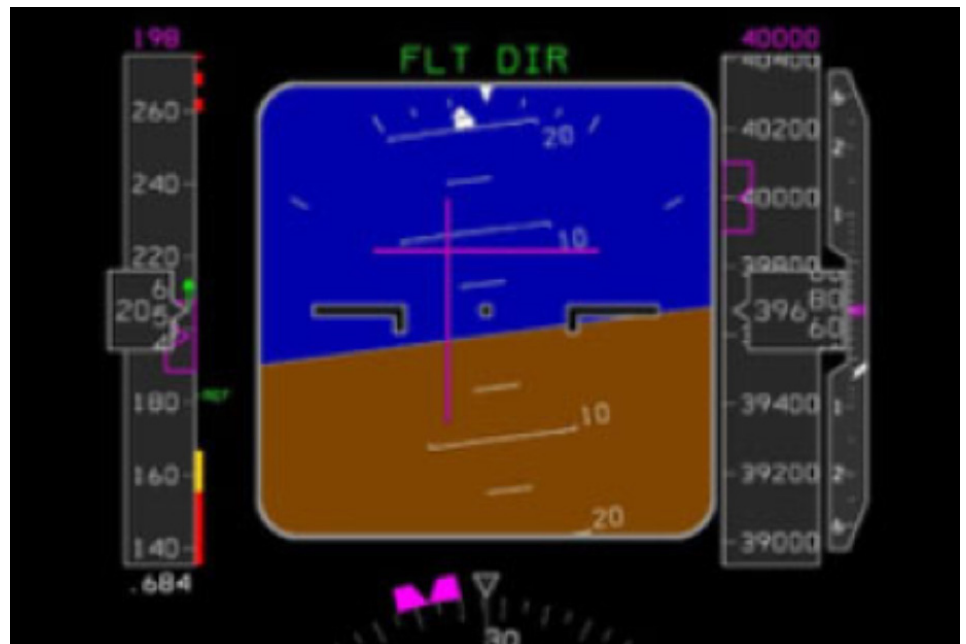
The TCL 3 testing will build on TCL 2 capabilities and investigate technologies and procedures for flying small UAS beyond line of sight in a more congested environment. Tests will include communication, navigation and surveillance with UAS in locations where there may be interrupted signals because of man-made and terrain features; sense and avoid flights to evaluate the effectiveness of detecting and resolving airborne conflicts; evaluations of system robustness using induced failures in the Flight Information Management System and UAS Service Supplier; and UAS landings and takeoffs from beyond visual line of sight locations.

Visual-Vestibular Active Psychophysics Experiment at the VMS

POC: [SCOTT REARDON](#) AND [PETER ZAAL](#)

On January 5, Airspace Operations and Safety Program researchers provided a demonstration of the Airspace Technology Demonstration-2 (ATD-2) system to the Collaborative Decision-Making (CDM) Flow Evaluation Team (FET) at NASA's ATD-2 laboratory located at the Charlotte Douglas International Airport. The team is a joint government and industry initiative aimed at improving air traffic flow management through increased information exchange among

aviation community stakeholders. The FET is a CDM sub-team that strives to increase system efficiency by reducing route coordination time and enhancing system planning through the creation of common situational awareness of potential route alternatives, procedures and coordination processes. The FET requested that a regular quarterly meeting be held in conjunction with the ATD-2 lab visit. The ATD-2 team presented a system overview and described the goals, benefits, and tools developed across the various user groups, from Air Traffic Control Tower personnel to ramp managers and controllers. A description of the data exchange, integration activities,



Primary Flight Display with Stall Recovery Guidance Symbology

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surface modeling, scheduling and metering also were provided. The FET expressed interest in the results of the field demonstrations.

TASAR Weather Integration Flight Trial 3 Pilot Focus Group Conducted in the ATOL

POC: [KELLY BURKE](#)

On January 12, Airspace Operations and Safety Program researchers provided an ATD-2 update to the FAA's NextGen Advisory Committee Subcommittee (NACSC) at their monthly meeting held in Washington, DC. The NextGen Advisory Committee (NAC) provides a venue where the FAA can solicit a consensus-based set of recommendations on issues that are critical to the successful implementation of NextGen. The NAC is also a forum to obtain a commitment of resources and synchronized planning between government and industry partners. The NACSC supports the NAC, and is composed of FAA and aviation industry representatives with broad knowledge and expertise related to the implementation of NextGen. The NACSC meeting included remarks from FAA Deputy Administrator (Acting) Victoria Wassmer and other regular participants. The ATD-2 briefing detailed past accomplishments, featured the concept animation

video and highlighted ATD-2 partnerships and stakeholder engagement activities. Under ATD-2, NASA is collaborating with the FAA and industry to conduct a field demonstration of surface departure metering, in response to a recommendation from the NAC. Several NACSC members expressed their support for ATD-2 and an interest in results from the field demonstration.

ATM-X Successfully Completes Key Decision Point-A Review

POC: [WILLIAM CHAN](#)

A multi-center planning team tasked with defining the Air Traffic Management-eXploration (ATM-X) Project successfully passed its Key Decision Point-A (KDP-A) milestone at NASA Headquarters on October 10. The ATM-X team was given approval to proceed to initial implementation and continue formulating project plans for the remainder of the three-year Phase 1 effort. ATM-X aims to enable equitable access to the airspace for all users, vehicles and missions by developing and demonstrating a new service-based paradigm by leveraging UTM principles and using a build and test approach. This KDP-A review was chaired by the ARMD Associate Administrator and supported by the Directorate Program Management Council,

AOSP's Independent Review Panel and the Center Aeronautics Research Directors. The review assessed the Phase 1 plans, Phase 2 planning and the trade space and development of a future ATM vision.

Early Tech Transfer of ATD-2 Technologies

POC: [JANE THIPPHAVONG](#)

The FAA Integrated Arrival Departure Surface (IADS) Research Transition Team (RTT) lead requested an early technical transfer of the Airspace Technology Demonstration-2 (ATD-2) technologies. The FAA NextGen office is the sponsoring organization for this effort. A technical interchange meeting was held on October 10 to discuss details of the early Tech Transfer of the IADS system for the Limited-Trajectory Based Operations (L-TBO) Project. The L-TBO team is interested in using the ATD-2 IADS system, particularly the Integrated Departure Arrival Capability, to demonstrate a subset of the TBO-based operational improvement increments identified for delivery into the National Airspace System (NAS) in 2025. Demonstration capabilities will be selected and integrated across all phases of flight to illustrate "closed loop" operations, collaboration, information sharing, feedback, synchronization and negotiation.

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The L-TBO project will also connect previous demonstration efforts supported by NextGen at the Florida Test Bed, including Mini Global, Aircraft Access to System Wide Information Management, 4D-Trajectory Datacomm and Advanced Trajectory Modeling. The early Tech Transfer provides another application of the ATD-2 system, and the FAA L-TBO Team will continue engagement with the NASA team to review progress and lessons learned. The FAA expressed appreciation for the work that the NASA ATD-2 Team has done so far, and is looking forward to continued partnership to improve the NAS.

NASA-KARI Collaboration on Airport Departure/Surface Management Capabilities

POC: [YOON JUNG](#)

NASA and the Korea Aerospace Research Institution (KARI) have been collaborating on surface management research since an agreement between the two organizations was signed in November 2014. This collaboration has recently led to a new Memorandum of Understanding (MOU) between KARI and the Incheon International Airport Corporation (IIAC), signed on September 29, to develop and deploy KARI's Airport Departure

Management and Surface Management Capabilities at Incheon International Airport. KARI and IIAC will jointly develop system requirements and test plans, and KARI will develop software and algorithms. KARI will also conduct human-in-the-loop simulations prior to system installation, which are scheduled to begin in early 2019. Shadow operations and field demonstrations will follow through 2020. In October, Daekeun Jeon, project manager of the field demonstration project, congratulated and credited the NASA-KARI collaboration team on this MOU and wrote the following statement: "...the field demonstration at IIAC would be a wonderful chance for us in that our technology can be applied to one of the best airports in the world. And also, there is no doubt that this chance was from the result of our research collaboration, so I would like to congratulate on this with you together."

NASA Contributes to the FAA's TFD Build 2 System Requirements Review

POC: [ANDREW GING](#)

On January 25, NASA participated in the joint government-industry Surface Collaborative Decision Making Team (SCT) Meeting, held in Washington, DC. The

team meets quarterly and consists of representatives from major U.S. passenger and cargo airlines, general aviation, the FAA and the National Air Traffic Controller Association. The team provides broad stakeholder input regarding requirements, policy, and procedures related to surface traffic-flow automation and data exchange.

The morning sessions included an update on the status and deployment plans for the Terminal Flight Data Manager Program, and a briefing by the MITRE Corporation on the effects of early scheduling departures into time-based traffic flows. The rest of the day was devoted to technical interchange on Airspace Technology Demonstration-2 (ATD-2). ATD-2 researchers presented an update on recent progress made towards the Phase 1 field demonstration at Charlotte Douglas International Airport. ATD-2 topics also included the status of the cost-benefits analysis and a preliminary study of the accuracy of airline gate departure intent data at Charlotte as a function of look-ahead time and airline category. Such analysis is critical for establishing expectations for the performance of ATD-2 departure scheduling functions in Phase 1. Interactions during the meeting provided valuable input on ATD-2 data collection

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plans for measuring benefits and for refining the investigation of departure intent accuracy. The team expressed their appreciation for NASA's overviews and technical discussions, and reaffirmed their desire for continued engagement on ATD-2 going forward.

Virtual Training on ATD-2 New Features

POC: [LINDSAY STEVENS](#)

On October 23, the NASA Airspace Technology Demonstration 2 (ATD-2) team conducted a virtual training session for American Airlines (AAL) Ramp Managers and the Ramp Managing Director on new features in the Ramp Management Tools. The Ramp Management Tools are part of the Integrated Arrival Departure Surface system deployed at Charlotte Douglass International Airport (CLT) and are in daily operational use in the AAL Ramp Tower as part of the Phase 1 Field Demonstration.

The Ramp Management tools consist of the Ramp Traffic Console (RTC) and Ramp Manager Traffic Console (RMTC). There are currently four RTCs and one RMTC deployed on the operational floor in the AAL CLT Ramp Tower. The new features include the ability to create a target for an existing flight, the ability to reposition flights on

the display, and updates to the flight menus. The Ramp Managers are looking forward to using these new features in the updated software release on October 24.

Interview Study Collaboration Meeting

POC: [PAUL LEE](#)

On October 11, Paul Lee met with FAA Human Performance Manager Jason Demalgalski, his team members, Ed Davis, Rachel Seely, and National Air Traffic Controller Association Human Performance representative Jay Barrett. The group discussed potential collaboration on an interview study with active controllers to identify human performance markers. The study probes markers that can lead to system breakdown under nominal and off-nominal situations, such as technology failure or an off-nominal even. The discussion was focused initially on getting access to three facilities – En Route, TRACON and Tower – to conduct one-hour interviews with more than 10 controllers per facility.

ATD-3 HITL Simulation for DRAW

POC: [CHESTER GONG](#)

The Airspace Technology Demonstration 3 sub-project completed the second human-



Summer Matter Experts Participating in DRAW Experiment.

in-the-loop (HITL) simulation data runs of the Dynamic Routes for Arrivals in Weather (DRAW) concept in October at the Ames Research Center's Air Traffic Control Laboratory. DRAW provides the ability to preserve metering operations during adverse weather conditions by using dynamic rerouting of arrival flights and balancing arrival demand across metering fixes. The DRAW HITL simulation number 2 featured a unique, two-part experiment design that focused separately on Traffic Management Coordinators (TMCs) and air traffic controllers. This set of simulations improved on the first DRAW HITL simulation that took place in May 2017 by collecting more data and using a design that addressed TMC-controller team technique dependencies. TMC simulation sessions were conducted from October 4 through 6 and from October 11 through 13. Both sessions included two teams of two recently-retired Fort Worth Center TMCs. The controller session

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was conducted from October 23 through 27, using scenarios derived from the TMC session. Controller test participants included seven recently-retired controllers from Los Angeles; Oakland, Calif. and Fort Worth, Texas En Route Centers. Two different controller-sector seating arrangements were used to create two sets of controller teams. Researchers observed differences in TMC management strategies, rerouting behavior and controller team performance, and validated the decision to utilize a two-part experiment design. Preliminary results indicate TMCs were able to evaluate and reroute weather-impacted arrival flights earlier with DRAW than without the concept.

Trajectory-Based Operations Exchange with FAA NextGen and MITRE CAASD

POC: [BRYAN BARMORE](#)

On February 8 and 9, the Airspace Technology Demonstration-3 (ATD-3) project held a technical interchange meeting (TIM) for the Dynamic Routes for Arrivals in Weather (DRAW) technology at FAA Headquarters. More than 20 representatives from NASA, FAA, and the MITRE Corporation attended, as well as a representative from the National Air Traffic Controllers Association. At the meeting, NASA was represented

by Stephanie Harrison from the Langley Research Center in Virginia, as well as Kapil Sheth and Chester Gong from the Ames Research Center in California. The meeting prompted an engaging discussion that successfully accomplished the objectives of the TIM, which were to first, provide detailed answers to FAA questions regarding DRAW technology and a Concept of Operations (ConOps); second, to receive feedback to help NASA revise the draft DRAW ConOps document; and finally, to present and receive feedback on the experiment plan for the first DRAW controllers-in-the-loop simulation, scheduled for May 2017.

AOSP Annual Project Reviews

POC: [TAMARA CROOM](#)

On October 30 and 31, AOSP conducted its Annual Project Review. The projects included the Airspace Technology Demonstration project, the Shadow Mode Assessment Using Realistic Technologies for the National Airspace System Testbed for Safe Trajectory-Based Operations project and the Safe Autonomous Systems Operations project. The primary purpose was to assess the demonstrated quality and performance for each of the projects during FY2017. The review process included the AOSP Program Director

and two panels of government technical management experts. The Independent Review Panel consists of non-NASA government experts—primarily representing the FAA and National Transportation Safety Board—and the Performance Review Panel includes key members of the Aeronautics Research Mission Directive leadership team. Those involved in this review provided independent perspective and input for consideration in their assessment of the projects.

ATM-X Project Activities Commenced

POC: [WILLIAM CHAN](#)

Following the successful Key Decision Point-A review, several activities commenced in support of the Air Traffic Management-eXploration Project. This included work related to Trajectory Based Operations (TBO) graceful degradation; Communications, Navigation, Surveillance (CNS) test-bed; airport architecture development and Aeronautical Telecommunications Network/Internet Protocol Suite (ATN/IPS) Standards development.

With regard to the TBO graceful degradation work, the team finished collecting interview data from retired controllers to explore interactions between degradation of the following

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three categories: (1) technology (e.g., DataComm); (2) severe weather; and (3) human performance (e.g., fatigue, high workload). The study explored the interactions between failures in technology, environment and human operators. Analyses of the data is in progress.

For the CNS test-bed, the team initiated a review of the Airborne Stand-off Radar (ASTOR) avionics system capabilities for implementation of CNS requirements into the test-bed capability. Specifically, an initial evaluation of system interface options is being considered for use in evaluation of network protocol profiles. Recent upgrades included installation of new Aeronautical Mobile Airport Communication System (AeroMACS) technology, including two new base station systems with transceiver equipment, antenna systems, power units and associated cabling. Additionally, the CNS test-bed will have continued security compliance upgrades and a security vulnerability assessment.

In support of the airport architecture development, the team initiated development of a virtualization design to enable airport architecture framework test and evaluation. Additionally, network design and configuration has started for initial capability simulation testing. In

support of the ATN/IPS Standards development, the team completed an initial draft of Domain Name System for an aviation use case. This work supports RTCA Special Committee 223, AeroMACS and Internet Protocol Suite profile development. The principal objective of this Minimum Operational Performance Standards effort is to modernize air-ground information exchange through the use of selected Internet Protocol version 6 protocols.

Visitors from ENAC

POC: [BANAVAR SRIDHAR](#)

Professors Daniel Delahaye and Marcel Mongeau from Ecole Nationale de l'Aviation Civile (ENAC) in Toulouse, France, visited Ames Research Center from October 31 through November 2. The visit was part of a proposed NASA-ENAC collaboration agreement in air traffic management (ATM) research.

ENAC is a major contributor to aviation research in Europe. Delahaye heads the Optimization and Automatic Control Group, Laboratory in Applied Mathematics, and Computer Science and Automatics for Air Transport. The research by the Optimization and Automatic Control Group has been applied to ATM in the areas of air traffic complexity, forecasting air traffic controller workload, air traffic planning, ground aircraft

taxiing, trajectory prediction and detection and resolution of conflicts. Delahaye met with Banavar Sridhar, Husni Idris, Eric Mueller, Antony Evans and Shannon Zelinski to gain a better understanding of the ATM research being conducted at Ames.

Technical Interchange Meeting for the Management by Trajectory (MBT) NRA

POC: [BRYAN BARMORE](#)

Langley Research Center's Advanced 4D Trajectory-Based Operations (4DT) research team conducted a technical interchange meeting with Mosaic ATM, Inc., regarding the company's ongoing Management by Trajectory (MBT) NASA Research Announcement (NRA) contract on November 2. The MBT NRA team is tasked with developing an MBT concept of operations, studying the impacts of possible changes in roles and responsibilities between various agents in the air traffic system and identifying the concept's potential impact on environment. Langley engineers and Mosaic discussed the contractor's evolving concept of operations, including details regarding assigned 4D trajectories, the National Airspace System (NAS) and trajectory constraints and the process of trajectory negotiation within an MBT air traffic environment.

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The NRA is supported by the Air Traffic Management-eXploration project and is focused on improving and enhancing the management and flow of airspace traffic within the NAS.

CAMPO Briefing Provided to FAA Chief Scientist

POC: [JENNIFER KIBLER](#)

A Human-in-the-Loop (HITL) evaluation of the Multi-Flight Common Routes (MFCR) tool took place at the Air Traffic Control Laboratory at NASA's Ames Research Center in California, March 6 through 8. The evaluation was a "shakedown" rehearsal in preparation for a formal evaluation by FAA traffic flow managers, scheduled for March 28 through 30. MFCR is a NASA-developed concept and associated decision support tool designed to assist air traffic flow managers in efficiently and continuously updating weather avoidance routes in case of convective weather system changes. MFCR groups together multiple flights to reduce the number of advisories that the traffic flow manager needs to evaluate, and merge these flights on a common route segment to provide an orderly flow of rerouted traffic. Four recently retired FAA traffic flow managers provided feedback on the MFCR tool and its concept of use. Specific

topics of evaluation included the operational acceptability of MFCR reroute advisories, the usability of MFCR's graphical user interface, and the overall viability of MFCR's concept of use. Data was collected across 120 evaluation points. Overall, the SMEs provided positive feedback, indicating that MFCR identified many time-saving rerouting opportunities that would be difficult to manually identify during air traffic operations in bad weather conditions.

American Airlines' Visit to ARC

POC: [PAUL LEE](#)

On November 8, Mike Sterenchuk, Air Traffic Controller Coordinator from the American Airlines (AAL) Integrated Operations Center (IOC), visited Ames Research Center to observe and discuss Integrated Demand Management (IDM) operations with the NASA IDM team. NASA's team demonstrated IDM operations under a convective weather scenario that efficiently distributed traffic flow across multiple meter fixes to Newark Airport by utilizing the Collaborative Trajectory Options Program (CTOP) and coordinating the demand management across Traffic Flow Management and Time Based Flow Management systems to reroute aircraft through less constrained airspace. During

the meeting, Tim Niznik from American Airlines' IOC joined via teleconference to brief the teams about recently completed CTOP trials at Dallas Fort-Worth International Airport (DFW). During the trials, AAL used the CTOP to distribute its DFW arrival traffic across multiple meter fixes and generate route alternatives to balance the traffic load and minimize airborne delays. Preliminary results suggested a good distribution of traffic across all of the meter fixes, showing few airborne delays and minimal departure delays for short-haul flights that often incur ground delays when the overhead traffic becomes too heavy. Although AAL's field trial at DFW is much less complex than the setup in the current IDM operations concept, the conceptual approaches between them have significant overlap and yield similar results, providing an encouraging input that IDM benefits can translate into actual operations.

NITRD Cyber-Physical Security Meeting

POC: [PAUL NELSON](#)

On November 16, Paul Nelson, AOSP Integration Manager for Cybersecurity and Communications, traveled to Washington to represent AOSP at a series of meetings related to the Networking and Information Technology Research

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and Development Cyber-Physical Security. The purpose of the meeting was to review and discuss the draft charter update for the Cyber-Physical Systems Interagency Working Group.

NASA-DHS-MIT Meeting

POC: [PARIMAL KOPARDEKAR](#) AND [SHON GRABBE](#)

On November 16 and 17, AOSP researchers hosted a meeting with industry partners and academia to develop a detailed roadmap for Unmanned Aerial System operations in the National Capital Region. The roadmap will balance the needs of security, safety and businesses. Parimal Kopardekar and Shon Grabbe hosted representatives from the Department of Homeland Security and the Massachusetts Institute of Technology at Ames Research Center for this two-day meeting. Additional subject matter experts participated remotely.

Urban Air Mobility Discussion

POC: [PARIMAL KOPARDEKAR](#)

On November 20, Eric Mueller and Ken Goodrich led a discussion on Urban Air Mobility (UAM) as a follow-up to their UAM presentation at the recent AOSP Strategy Meeting held at Ames Research Center on October 12 and 13. Attendees shared information regarding ongoing and upcoming UAM research efforts

by partners in academia, industry and across several NASA projects. Attendees also discussed the need to communicate, coordinate, collaborate and leverage each other's research efforts, especially for the UAM Grand Challenge. UAM vehicle capabilities and UAM airspace integration were presented as part of a two-part UAM Grand Challenge. NASA is planning internal follow-up discussions and internal outreach activities for the broader aviation community.

Airline Executives visit ATD-2 Field Demonstration

POC: [SHAWN ENGELLAND](#)

On November 28, NASA hosted vice presidents from United Airlines and American Airlines (AAL) at Charlotte Douglas International Airport (CLT), the Airspace Technology Demonstration-2 (ATD-2) Field Demonstration site. AAL Vice President of Integrated Operations Control Lorne Cass and United Airlines Vice President of Network Operations Tracy Lee participated in ATD-2 Shadow Session 14. During this session, NASA researchers briefed the FAA and Airline Field Demo Partners on Phase 1B results and expectations for Phase 1C. These briefings were followed by a visit to the FAA Air Traffic Control Tower and Terminal RADAR

Approach Control facilities where FAA traffic managers demonstrated how the ATD-2 Integrated/Arrival/Departure/Surface (IADS) system was being used in daily operations. Later, the executives visited the CLT ramp tower where AAL traffic managers and controllers manage traffic in the non-movement areas, such as the ramp tower, of CLT airport. Here, the executives saw the ATD-2 IADS system in use at five traffic management and control positions in the ramp tower.

This familiarization visit was significant because both executives have strong connections to the ATD-2 Field Demonstration. Cass has been instrumental in developing the Surface Collaborative Decision Making concept, which is foundational to NASA's ATD-2 IADS system. In addition to his duties at United Airlines, Lee serves as co-chair of the NextGen Advisory Committee Subcommittee (NACSC), which is the implementing organization for the NextGen Advisory Committee (NAC). The NAC provides a venue where the FAA can solicit a consensus-based set of recommendations on issues that are critical to the successful implementation of NextGen. It is also a forum to obtain a commitment of resources and/or synchronized planning between

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government and industry. The ATD-2 Field Demonstration at CLT is a collaboration among FAA, industry and NASA in response to NAC recommendations and supported by the NACSC.

General Aviation (GA) User Forum at CLT

POC: [DEBI BAKOWSKI](#) AND [BECKY HOOEY](#)

On November 29, MITRE, the FAA NextGen Organization (ANG) and NASA held a General Aviation (GA) User Forum at Charlotte Douglas International Airport (CLT). The forum focused on information sharing for GA flight operations at CLT. In addition to representatives from MITRE, NASA and FAA/ANG, participants included representatives from the National Air Traffic Controller Association, CLT Air Traffic Control Tower, American Airlines, National Business Aviation Association and corporate flight operators at CLT. An overview of the Air Traffic Demonstration-2 (ATD-2) Field Demonstration and the role of data exchange and integration in the ATD-2 Integrated/Arrival/Departure/Surface system was presented by NASA. NASA also discussed the importance of information sharing for GA operations at CLT and lesser-equipped airports.

MITRE described a prototype mobile device application they

developed under FAA/ANG sponsorship. They also outlined the procedures that GA pilots are using to submit an Earliest Off-Block Time/Ready-to-Taxi Time in the current beta-test of the Mobile App. Pilots provided feedback that NASA can use to understand GA operations and their departure procedures at CLT. Specific data elements that may be available to pilots were also discussed. Pilots provided additional feedback on the potential usefulness of receiving each of the data elements.

DWG Tech Transfer Package #1 and FAA/UTM Discussion

POC: [JOEY RIOS](#)

On December 5, NASA researchers supporting the Unmanned Aerial System (UAS) Traffic Management Project (UTM) project hosted FAA colleagues under the Data Exchange and Information Architecture Working Group (DWG) for a daylong discussion of UTM and the FAA Pilot Program at Ames Research Center. Additionally, NASA transferred its own artifacts to the FAA as part of DWG Package #1. The artifacts consisted of the Flight Interval Management System Software Architecture, the UTM Support System Specifications, the UAS Operator Interface Control Document and the UTM Application Programming Interfaces. This technology transfer provides the

FAA with important information for the development of the UTM system to be tested and deployed in 2019 by the FAA, and supported by NASA.

ATM-X Partnership Engagement Meetings

POC: [WILLIAM CHAN](#)

From December 5 through 7, the Air Traffic Management-eXploration (ATM-X) project staff was in Washington to participate in various partnership meetings with representatives from industry, academia and the FAA. William Chan, ATM-X Project Manager, met with Massachusetts Institute of Technology/Lincoln Laboratory for an Air Traffic Controller workshop. Chan also attended a meeting with FAA and JetBlue for discussions about the Northeast Corridor, as well as other meetings with industry partners for follow-on discussions related to trajectory negotiation, data communications and time-based metering.

UTM USS Implementers Collaborative Demonstration

POC: [JOEY RIOS](#)

On December 13, the Unmanned Aerial Systems (UAS) Traffic Management (UTM) project team hosted a collaborative demonstration with nine external UTM Support System (USS) implementers in the largest UTM interoperability test to date. The external implementers

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included Airmap, General Electric, Amazon, ANRA Technologies, Avison Robotics, the Texas FAA Test Site, Rockwell Collins, Simulyze and Transtrex. With NASA's participation, 10 USSs shared data and simulated small UAS operations in a demonstration that prepared the participants for the Technical Capabilities Level (TCL) 3 flight testing, which will start in February 2018. Most of the organizations participating will be supporting at least one TCL 3 test site in a USS role. Ames Research Center researchers managed the NASA USS, the USS data collection and the Flight Interval Management System.

Training of Alaska Airlines Personnel at ARC

POC: [KAPIL SHETH](#)

The air-ground integration effort within the Airspace Technology Demonstration-3 sub-project, called Multi-Agent Air-Ground Integrated Coordination (MAAGIC), is currently underway with Alaska Airlines (ASA) as the prime industry partner. The ground-based reroute advisory component, National Airspace System Constraint Evaluation and Notification Tool (NASCENT), is close to virtual deployment at the ASA System Operations Center in Seattle. Six members of the ASA team—four dispatchers and two pilots—visited Ames Research Center on December

13 for additional information and training on operating the NASCENT system. NASA provided the ASA team with an introduction of the concept, algorithm and benefits, and a demonstration of the software in the Air Traffic Control Lab that included hands-on experience. The ASA participants exhibited their enthusiasm about having NASCENT running at ASA, and about the entire MAAGIC effort to gain more efficiencies from their flight operations.

MFCR Technology Transfer to the FAA

POC: [KAPIL SHETH](#)

Multi-Flight Common Route (MFCR) forms part of the Airspace Technology Demonstration-3 (ATD-3) suite of technologies, and includes the National Airspace System Constraint Evaluation and Notification Tool (NASCENT), an implementation of NASA's single-flight rerouting Dynamic Weather Routes (DWR) concept in NASA's Future Air Traffic Management Concepts Evaluation Tool. NASCENT calculates time- and fuel-saving advisories that provide efficient routes by avoiding known airspace constraints, such as convective weather and special-use airspace. The DWR concept was extended within NASCENT by clustering similar advisories for multiple flights and

groups of flights sharing common route characteristics. With technical and subject matter expert support from the FAA, NASA performed human-in-the-loop simulation evaluations, the results of which were detailed in the MFCR Concept of Operations and Functional/Performance Requirements. On December 14, the ATD-3 sub-project proudly transferred the MFCR technology to the FAA. The FAA has closely monitored the MFCR efforts, which have been found to be applicable to its Advanced Flight-Specific Trajectories (AFST) program. AFST is a part of the next generation Collaborative Air Traffic Management Technologies Work Package 5.

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TASAR Presentation to NASA Industry Forum

POC: [DAVID WING](#)

On October 3, David Wing from Langley Research Center was invited to speak at the NASA Industry Forum sponsored by the NASA Office of Small Business Programs (OSBP). Glenn Delgado, Associate Administrator of OSBP, had specifically requested a presentation of a current Langley research program involving both small and large businesses. The Langley Office of Procurement invited Wing to give the briefing. His presentation, entitled "Traffic Aware Strategic Aircrew Requests (TASAR) NASA Flight Deck Application for En Route Flight Optimization," was well received and elicited many questions from forum participants. The use of multiple NASA Research Announcement contracts, a Space Act Agreement with a U.S. airline and the positive response and interest in commercialization by industry made TASAR the perfect selection for this presentation. In 2014, TASAR contractors Engility Corporation and Advanced Aerospace Solutions won awards for Langley Small Business Contractor of the Year and Agency Small Business Subcontractor of the Year, respectively. TASAR research is sponsored by the Airspace Technology Demonstration Project in AOSP.

TASAR Presentation to Aviation Weather Panel

POC: [TIMOTHY LEWIS](#)

Langley Research Center researcher Timothy Lewis was invited to speak to the NextGen Weather User's Forum at the Friends and Partners in Aviation Weather Fall Forum on October 12. The subject of the talk was the ongoing flight trial activity to integrate convective weather data into the Traffic Aware Strategic Aircrew Requests (TASAR) Traffic Aware Planner (TAP). TASAR Flight Trial 3 is being conducted on board the NASA Langley HU-25A aircraft to develop and evaluate the integration of onboard weather radar with ground-based weather products within the TAP software. This integration will allow TAP to provide weather-aware trajectory optimization recommendations to the aircrew during en route operations. The development of this capability is in support of the Multi-Agent Air-Ground Integrated Coordination sub-project under Airspace Technology Demonstration-3. This meeting supported TASAR's goals for outreach, partnership and technology transfer. In particular, this was a forum to present the weather data needs for TAP to a broad range of interests in the aviation weather community. The ultimate goal of the TASAR

project is to transfer NASA's technology to industry vendors to maximize operational benefit to airlines and other airspace users.

Parimal Kopardekar receives ATCA Award

POC: [KATHARINE LEE](#)



The 2017 ATCA President's Citation of Merit Award

On October 19, Ames Research Center's Senior Scientist for Air Transportation Systems Parimal Kopardekar was presented with an Air Traffic Control Association (ATCA) President's Citation of Merit Award. ATCA recognizes the outstanding achievement of individuals and organizations engaged in the development, operation or maintenance of the worldwide air traffic control system. Kopardekar's award was

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for his technical and community leadership in Unmanned Aircraft System (UAS) Traffic Management, and advancing safe UAS integration forward.

TASA Research Highlighted in Boeing and NASA Media Releases

POC: [KYLE ELLIS](#)

NASA's Technologies for Airplane State Awareness (TASA) research on advanced flight deck concepts and technologies to improve safety was recently highlighted in a series of media releases from Boeing and NASA. Researchers from the TASA sub-project have been evaluating Synthetic Vision Systems (SVS) for their ability to improve attitude state awareness in pilots. The TASA research paves the way for certification standards to integrate such systems as a baseline capability in future transport category aircraft to improve aviation safety. The SVS research was conducted as a series of evaluations called the Augmented Flight Deck Countermeasures (AFDC) experiment series.

The current instantiation of the experiment series highlighted in the referenced media releases, AFDC-3B, is scheduled to be completed by the first quarter of FY18. Thanks to a newly signed Space Act Agreement between NASA and Boeing, AFDC-3B will

evaluate international pilot trainees, some with fewer than 500 hours of experience, for their ability to maintain attitude state awareness with and without SVS during several off-nominal, compound failure event scenarios. The testing will take place in Boeing's 787 full flight simulator (FFS) in Miami, fully integrated with SVS displays and other NASA technologies. The Boeing Miami 787 FFS will be the first FFS certified for training to be integrated with SVS for research purposes. This newly established collaboration with Boeing opens the door to a multitude of future research opportunities by providing access to the international pilot community in a real-world training environment, enabling NASA to better inform the development of SVS and other advanced flight deck technologies with an increased level of diverse perspective. The findings from the AFDC-series of research experiments are being directly reported to the international RTCA subcommittee-213 to support development of Minimum Aviation System Performance Standards for SVS for attitude state awareness.

Related Links:

<http://www.boeing.com/features/2017/10/space-act-agreement-10-17.page>

<https://www.nasa.gov/feature/langley/nasa-boeing-testing-synthetic-vision-technologies>

<http://www.aviationtoday.com/2017/12/18/boeing-nasa-test-nextgen-synthetic-vision-787-sims/#.WjhNzXOtx4w.email>

Commercial UAV Show

POC: [MARCUS JOHNSON](#)

From November 15 through 16, the Commercial Unmanned Aerial Vehicle Show in London highlighted technology advancements from the Unmanned Aerial Systems (UAS) industry, and hosted speakers and panels to discuss ongoing issues and challenges for UAS integration. NASA's Marcus Johnson gave the opening keynote speech entitled "Developing an Autonomous Air Traffic Management System and Defining the Future of the Drone Industry."

NAC Aeronautics Committee Meeting

POC: [TAMARA CROOM](#)

Dana Gould and John Koelling from Langley Research Center participated in the NASA Advisory Council (NAC) Aeronautics Committee meeting at NASA's Armstrong Flight Research Center on November 15 and 16. The Associate Administrator for Aeronautics, Jaiwon Shin, and the Aeronautics Research Mission Directorate Program Directors were in attendance. Agenda topics included the Low Boom Flight Demonstrator, Hypersonics and

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the System Wide Safety Assurance Project Objectives and Content.

ATD-1 Flight Test Paper Selected Among Best at EIWAC 2017 Conference

POC: [BRIAN BAXLEY](#)

A presentation of results from NASA's Airspace Technology Demonstration-1 (ATD-1) 19-day flight test of an Interval Management (IM) avionics prototype was presented at the 5th Electronic Navigation Research Institute (ENRI) International Workshop on Air Traffic Management (ATM)/ Communications Navigation Surveillance (CNS) (EIWAC2017), held in Tokyo, Japan, on November 16. ENRI is the Japanese government research entity for ATM and CNS. The NASA IM concept entails assigning an aircraft to a specific spacing interval behind a preceding aircraft, and adding new onboard IM avionics that calculate the airspeed at which pilots should fly to achieve the required spacing interval. The flight test results demonstrated that the predominately NASA-developed IM concept and aircraft spacing algorithm met the 5-second design goal for many of the IM operations. This is a substantial improvement over the spacing interval typically observed today, which can be as much as 15 to 20 seconds greater than the desired spacing. MITRE,

NASA, the FAA and the aviation industry are key contributors to the IM concept and in creating the international standards for ICAO. MITRE has calculated that delivering aircraft to the airport with a 5-second standard deviation could potentially allow for up to 10 more arrivals per hour in certain environments—a substantial improvement in airport throughput and a significant reduction in the delay aircraft experience during high-traffic conditions. The paper was presented by Langley Research Center's Brian Baxley, with co-authors from Honeywell and Boeing, and was selected by the EIWAC2017 committee to be included in a book that compiles the best papers from the conference, to be published in 2019.

ARC Researchers Present at the Conference on Modeling and Simulation in

POC: [BIMAL APONSO](#)

From March 27 through 29, John Cavolowsky, NASA's Airspace Operations and Safety Program director, attended and participated as a panel member at the 2nd Annual FAA Unmanned Aircraft Systems (UAS) Symposium. The event was co-hosted by the FAA and the Association for Unmanned Vehicle Systems International in Reston, VA. The Symposium focused on the potential for UAS and methods

to achieve its full integration into the National Airspace System (NAS). Attendees heard directly from senior FAA officials about the UAS regulatory environment, and had an opportunity to talk face-to-face with FAA experts about the operational challenges facing UAS pilots today. Cavolowsky participated in one of the workshop sessions covering topics such as options for operating in the NAS, the future of airspace authorization and how to address challenges around traffic management, infrastructure and security.

RTCA AeroMACS Internet Protocol Suite (IPS) SC-223 Plenary Meeting

POC: [RAFAEL APAZA](#)

NASA researchers supporting the Airspace Technology Demonstration project participated in the RTCA Aeronautical Mobile Airport Communication System (AeroMACS) IPS SC-223 Plenary Meeting in Washington from December 4 through 6. Researchers have been supporting the design, testing and standardization of Internet Protocol technology, including protocol profile performance evaluation at all levels. Participation at this meeting supports the critical development of IPS mobility protocol standards for Communications Service Network access that will enable information exchange between

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aircraft avionics, Airline Dispatch, new vehicle entries into the airspace and Air Traffic Service Provider.

MIT Lincoln Laboratory Air Traffic Control Workshop

POC: [BRYAN BARMORE](#)

Langley Research Center researcher Bryan Barmore, attended the 7th Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL) Air Traffic Controller Workshop held at FAA Headquarters in Washington on December 5. MIT/LL hosts this annual workshop to highlight some of the research in air traffic control. This year's workshop focused on improved weather sensing and data sharing, future airborne surveillance, ADS-B uses and the integration of small and large Unmanned Aerial Systems. Tom Prevot, Uber's lead for airspace integration and formerly with NASA, presented the keynote talk and presented Uber's vision for Urban Air Mobility. More than 100 people attended the workshop and represented government, industry and academia. Several topics discussed will help focus research in the new Air Traffic Management-eXploration Project.

UAS Technical Analysis and Applications Center (TAAC) Conference

POC: [MARCUS JOHNSON](#)

Marcus Johnson, Deputy Project Manager, Unmanned Aerial

System (UAS) Traffic Management (UTM) project, represented the Airspace Operations and Safety Program at the UAS Technical Analysis and Applications Center (TAAC) Conference in Santa Fe, New Mexico, from December 5 through 7. The TAAC Conference is a gathering of government and industry leaders who discuss critical issues regarding UAS in a productive, value-added environment. Speakers from several federal agencies, aviation user groups, private industry and universities attended. UAS TAAC attracts a diverse group of attendees, and offers timely and relevant topics presented in both open and classified venues. Johnson, who works primarily at Ames Research Center, presented the results from UTM's Technical Capabilities Level (TCL) 2 testing and discussed plans for future TCL 3 and TCL 4 technology development and flight tests.

High Confidence Software and Systems (HCSS) Meeting

POC: [JOHN KOELLING](#)

On December 6, NASA researchers supporting the System-Wide Safety (SWS) project attended the High Confidence Software and Systems (HCSS) meeting in Washington. HCSS is part of the Networking and Information Technology Research and Development program, which is the United

States' primary source of federally funded work on advanced IT. The agenda included the following two topics of significant interest to SWS research: a presentation on the Air Force Research Laboratory's "Summer of Innovation" program, and a workshop on the industrialization of formal methods.

ARMD Mission Directorate Review (MDR)

POC: [TAMARA CROOM](#)

On December 11 and 12, the Associate Administrator for Aeronautics, Jaiwon Shin, hosted the Aeronautics Research Mission Directorate (ARMD) Review at Ames Research Center. All ARMD program offices reported the status of their programs during FY17 to track and document the progress made towards the strategic thrusts and outcomes. Center management, aeronautics research directors and project managers were in attendance.

ICAO UTM Panel Presentation

POC: [PARIMAL KOPARDEKAR](#)

Parimal Kopardekar, the NASA Senior Technologist for Air Transportation Systems, was invited to be a panelist at the International Civil Aviation Organization's (ICAO) second Global Air Navigation Industry Symposium in Montreal on December 12. The conference

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featured two Unmanned Aerial Systems Traffic Management (UTM) panels, the first of which focused on low-altitude operations, and the second on a discussion of high-altitude, upper-class E airspace, which is more than 60,000 feet in elevation. Kopardekar's panel included participants representing Amazon Prime Air, Thales, Google X and the Nanyang Technological University from Singapore. Participants showed interest in applying the NASA-developed UTM construct for high-altitude operations.

NASA Aeronautics Management Offsite

POC: [TAMARA CROOM](#)

From December 13 through 15, the NASA Associate Administrator for Aeronautics, Jaiwon Shin, held an Aero Management Offsite at Ames Research Center. Attendees included Aeronautics employees from NASA Headquarters and the four Aero Centers. The theme for this year's offsite was learning from people and organizations outside of NASA, including both the traditional aviation market and new emerging markets, to better understand new developments in the industry. This year's agenda featured speakers from Boeing, Zee Aero and Intuit, and included industry tours in the Silicon Valley area.

Committee on Assessing the Risks of Unmanned Aircraft Systems (UAS) Integration Meeting

POC: [PARIMAL KOPARDEKAR](#)

From December 13 through 15, Parimal Kopardekar represented AOSP at a presentation to the Committee on Assessing the Risks of Unmanned Aerial System (UAS) Integration in Irvine, Calif. The National Academies of Sciences, Engineering, and Medicine appointed an ad hoc committee with representation from industry, academia and government to conduct a study. This study will evaluate the potential of probabilistic assessments of risks, review other risk assessment methods for streamlining the process of integrating UAS into the National Airspace System and identify supporting research and development opportunities in the aviation field.

Alaska Airlines TASAR Flight Trials Highlighted in Avionics Magazine Article

POC: [DAVID WING](#)

The feature article in the December 2017-January 2018 online issue of Avionics Magazine highlights Alaska Airlines' Traffic Aware Strategic Aircrew Requests (TASAR) operational trials in partnership

with NASA to test NASA's Traffic Awareness Planner (TAP) software application while in operational use. TAP enables the NASA TASAR concept—the software installed on a connected Electronic Flight Bag—identifies reroute opportunities to optimize the aircraft's en-route trajectory, saving flight time and fuel. TAP also takes into account local traffic, weather and special use airspace, all of which increase the likelihood of Air Traffic Controller approval of the requested reroute. The TAP software was installed on three aircraft in late 2017, and has undergone several months of preliminary testing. Pilot use of the technology will begin in early 2018.

Related Link:

<http://interactive.aviationtoday.com/avionicsmagazine/december-2017-january-2018/alaska-airlines-fleet-upgrades-and-flight-innovation/>

National Aeronautics and Space Administration

Headquarters

300 E. Street, SW

Washington, DC 20024

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