National Aeronautics and Space Administration

AOSP Newsletter

Airspace Operations and Safety Program (AOSP)

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AOSP IN THE NEWS

NASA Plans Major Test of Drone Management System

On April 18, an *MIS Asia* article reported a NASA-developed air traffic control system for drones could take a major step forward when up to 24 drones take to the skies from locations across the U.S. in the agency's first coordinated test. Called UTM, for unmanned aircraft system traffic management, the platform is seen as a key safety system that would allow greater numbers of drones to fly in the sky and avoid mid-air collisions with piloted aircraft and other drones.

NASA's Drone Traffic Control System

A *Popular Science* article published on April 19 pointed out that because small drones, unlike other aircraft, don't broadcast their location, tracking them while aloft is difficult. That's why the FAA is working with NASA to come up with an unmanned aerial system traffic management system: air traffic control for drones.

NASA Tests Drone Monitoring System at Moffett Field

On April 19, the San Francisco CBS TV affiliate recognized NASA's Ames Research Center at Moffett Field as making aviation history with its most complex test to date of a drone air traffic management system.

NASA Puts Nationwide UTM for Drones to the Test

On April 20, a *Gizmag* story profiled NASA's air traffic management system for drones as the agency carried out its first coordinated testing, assessing how well the system accommodates flights at different locations across the country. NASA has been developing its Unmanned Aircraft System (UAS) Traffic Management (UTM) program for some time. UTM could provide a finalized solution that would leverage elements of terrestrial traffic management, including an aerial system of roads, rules, lights and lanes. In practice, this could translate to airspace corridors, dynamic geofencing to prevent drones wandering off course, and methods that would take into account such variables as severe weather, congestion, and route planning on the fly.

Drone UTM to Enhance Safety

R & D Magazine reported on April 20 that NASA's concept for a possible UTM system would safely manage diverse UAS operations in the airspace above buildings and below crewed aircraft operations in suburban and urban areas. "UTM is designed to enable safe low-altitude civilian UAS operations by providing pilots information needed to maintain separation from other aircraft by reserving areas for specific routes, with consideration of restricted airspace and adverse weather conditions," said project lead Parimal Kopadekar in a statement following an initial test of the system in the fall.

NASA Testing for Close Encounters of the UAS Kind

In the wake of the unprecedented April 19 simultaneous test of unmanned aircraft systems (UAS) at NASA sites across the U.S., Aviation Week on April 25 noted that the agency is preparing to deliberately fly its remotely piloted Predator B aircraft into close encounters with a variety of "intruder" aircraft so as to gauge effective sense-and-avoid procedures.

NASA Conducts Tough Test for Drone Swarms

On April 25, an *Engadget* article pointed out that, if piloting a single drone is challenging, managing an airborne drone swarm is even trickier, especially considering the constant threat of collision. During the joint

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NASA/FAA UTM test, 24 drones were assessed in flight over several locations in the space of three hours. For good measure, researchers threw dozens of virtual aircraft into the air traffic management mix.

UTM Test Assesses Potential Collision Risks

Tech Times on April 26 reported that NASA successfully flew 22 drones in simultaneous testing, evaluating its unmanned aircraft system traffic management (UTM) research platform for rural operations. Running for three hours, the test was conducted at FAA test sites across the country, involving a total of 24 drones, of which 22 were flying simultaneously at one point. NASA's UTM research platform checked for conflicts during the flight, gave approval or rejections to flight plans, and delivered notifications on constraints to the users. Likewise, engineers at NASA's Ames Research Center were tasked with operations and system load monitoring, as well as qualitative feedback gathering so as to identify capability gaps to inform ongoing UTM research.

Optimizing Human Drone Operation

On May 4, The Register highlighted an excerpt from NASA's UTM project page that explains that UTM should be able to operate without human operators monitoring all vehicles. NASA is due to deliver the results of its research in 2019, in the form of airspace integration requirements the FAA can evaluate and verify.

AeroVironment and SmartC2 Join NASA's UTM TCL 2 Demo

The May 5 issue of Aerospace Technology noted that small unmanned aircraft systems solutions provider AeroVironment and SmartC2 are slated to join NASA's unmanned traffic management (UTM) technology capability levels (TCL) 2 flight demonstration scheduled for October. The proposed demonstration will build on results from UTM TCL 1 field testing last August, as well as ongoing operational demonstration and field testing of AeroVironment's Puma AE (All Environment) small unmanned aircraft system, to concentrate on beyond-visual line-of-sight operations in thinly populated areas.

BBC Strikes a Note of Caution

Despite NASA's and the FAA's April unmanned aircraft system traffic management flight-demonstration success, and the rapid development of drone "sense and avoid" technology, the British Broadcasting Company (BBC) on May 5 reported that regulators will need much convincing before allowing aerial motorways above dense urban areas.

Millions of Drones Aloft by 2020

A USA Today article on June 6 reported that Parimal Kopardekar, NASA's principal investigator for drone traffic management, told a conference held by of the American Institute of Aeronautics and Astronautics that an estimated 2.7 million commercial drones will be flying by 2020. This despite the fact that only 5,300 commercial permits have so far been granted nationwide by the FAA to fly in the "drone zone."

NASA, Transportation Dept. Launch Aviation Test Lab

The Hill reported on June 24 that NASA and the Department of Transportation launched a new aviation test lab at North Carolina's Charlotte Douglas International Airport in an effort to streamline air arrivals and departures, reduce congestion in the skies and improve aviation safety. The initiative is the next major step in the rollout of the satellite-based Next Generation Air Transportation System, known as NextGen, to improve the nation's air traffic control. The pilot project is designed to run for five years.

NextGen Sets the Stage for Greener Aviation

PhysOrg.com noted in a June 24 story that NASA is working toward

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a greener future in aviation, where airplanes push back from the gate, taxi to the runway and take off more quickly. A more efficient, precise trip by an airplane from the gate to takeoff reduces the amount of time its jet engines spend running on the ground, reduces noise and emissions levels at the airport, and reduces passenger wait times.

Before this future can be realized, however, the tools used today to manage arrivals and departures need to be upgraded. In the Next Generation Air Transportation System (NextGen) world, computers will streamline the sharing of information between all involved in arrivals and departures – air traffic controllers, managers, flight crews – so that an airplane's movements through every point of its flight are more precisely coordinated. Especially at the world's busiest airports, sharing information between the systems used to monitor an airplane's flight will be key for more dependable and efficient air travel.

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NRA Update: Accelerating ATM into the Cloud

POC: WILLIAM CHAN

On April 4, the Mosaic Air Traffic Management (ATM) Team presented their progress and plans for year two of their NASA Research Announcement (NRA) work, "Accelerating ATM Into The Cloud." Mosaic demonstrated their prototype software that would accelerate the ability of the Shadow Mode Assessment using Realistic Technologies for the National Airspace System (SMART-NAS) Test-bed to identify and connect to specific ATM software components using cloud services. The demonstration included the simulation user interface, or dashboard, that enables a query of specific ATM components and then ensures that all other necessary components are also made available. A method to query the attributes of each component was also demonstrated. A discussion of securely working with the cloud was also presented by the Harris Corporation.

TASAR Team Briefs Immarsat, AA and GE

POC: DAVID WING

On April 13, NASA Langley Research Center engineer David Wing gave a presentation of the Traffic Aware Strategic Aircrew Requests (TASAR) System to Inmarsat, provider of satellite communications and surveillance to 95% of the world's oceanic traffic. TASAR offers cockpit-based technology that uses connectivity to internal and external data sources in the computation of flight-optimizing trajectory changes.

Having learned of TASAR through their industry contacts, Inmarsat contacted Mr. Wing and requested further information on the TASAR technology and project. Inmarsat indicated the industry is on the cusp of a paradigm shift in how data is delivered to the aircraft. Following the briefing, they commented that TASAR is "going to be one of the first applications introduced to the cockpit which utilizes the benefits of an Internet Protocol pipe off the aircraft." In addition to an expression of interest in collaboration with NASA, Inmarsat expressed commercial interest in NASA's TASAR technology and requested information on software licensing.

At another meeting on May 24, David Wing and Dr. Kelly Burke of NASA Langley met with American Airlines (AA) Director of Airspace Optimization and Aircraft Technical Operations Captain Brian Will regarding the airline's interest in the TASAR technology. Capt. Will evaluated TASAR in the November 2013 TASAR flight trial and requested this meeting to get a technology update and discuss options for AA to evaluate the technology in revenue service, potentially in collaboration with NASA.

AA's interest in TASAR, besides providing tangible operational benefits, lies in its unique potential to integrate and focus several disparate AA technology programs, including electronic flight bags, automatic dependent surveillance broadcast, and data communications. AA is also currently evaluating the Dynamic Weather Routes (DWR) dispatcher technology developed at NASA's Ames Research Center in their Integrated Operations Center.

Collaborative opportunities under NASA's third Airspace Technology Demonstration (ATD-3) Subproject were discussed, where a key focus of ATD-3 is air-ground integration. Capt. Will proposed a larger follow-up meeting to be held at AA headquarters to assess the feasibility of TASAR technology integration in AA aircraft and to continue discussions on potential partnership under ATD-3 in the area of air/ground integration.

At another meeting on June 3, David Wing and Dr. Kelly Burke gave a presentation to GE Aviation, a leading manufacturer of aircraft avionics. GE Aviation expressed interest in the advanced route-optimizing functionality of the TASAR software application, Traffic Aware Planner (TAP). A real-time demonstration of TAP was provided, sparking an interest by GE Aviation in how they might integrate TAP functionality into their

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Flight Management System (FMS) or provide a digital connectivity between the tools for direct interchange of FMS and TAP data.

GE Aviation inquired about TAP software licensing options, and they expressed an interest in a potential partnership with NASA to advance the TASAR technology and conduct possible operational demonstrations of the proposed integrated functionality. Two areas of potential collaboration discussed were integration with data communications and increasing the certification level of TAP functionality (which is currently an advisory capability hosted in an electronic flight bag), both of which would be instrumental to incorporating TAP's capabilities into a certificated FMS. Ongoing discussion is expected.

ATD-2 Surface HITL Shakedown Simulation

POC: SAVVY VERMA

The Airspace Technology Demonstration (ATD)-2 subproject completed a human-in-the-loop (HITL) shakedown simulation the week of April 25 in the NASA Ames Research Center's FutureFlight Central (FFC) air traffic control tower simulator. The simulation represented the first test of several of the ATD-2 tools planned for deployment at the American Airlines (AA) Ramp Tower at CLT in Charlotte, North Carolina. Airport ramp operations were simulated with AA and flight research associates participants acting as ramp controllers and ramp managers. The HITL simulation examined the transition between airport configuration changes, operations when ramp advisories are turned off, new features in the ramp traffic console and the newly developed ramp manager traffic console displays. The simulation was also part of an April 28 NASA Ames tour for FAA Deputy Administrator Mike Whitaker.

Airspace Operations Discussed at CDM Meeting

POC: KAPIL SHETH AND SHAWN ENGELLAND

NASA Ames Research Center engineers Kapil Sheth, Shawn Engelland and Connie Brasil attended the FAA's Collaborative Decision-Making (CDM) Spring Meeting on April 20, held at the Dallas-Fort Worth (DFW) International Airport in Texas. NASA's research and development in airspace operations was clearly represented at this meeting. Several speakers referred to NASA's air traffic management work covering the Airspace Technology Demonstration 2 Subproject, NASA's role in testing at the Charlotte Douglas International Airport in North Carolina, human-in-the-loop simulations for the integrated demand management effort within the the Shadow Mode Assessment using Realistic Technologies for the National Airspace System (SMART-NAS) Project, and weather routing in the Airspace Technology Demonstration 3 Subproject.

Speakers included DFW Executive Vice President Jim Crites, who provided opening remarks; CDM sub-team leads, including Rob Goldman, Surface CDM Team industry lead; Ernie Stellings, Flow Evaluation Team industry lead; and Vern Payne of the Traffic Flow Management Deployment Team. Manager of American Airline's (AA) Integrated Operations Center Mr. Lorne Cass also elaborated on the successful partnership between NASA and AA. The sub-teams indicated continued interest in NASA collaboration and involvement.

ATD-1 Highlighted During Congressional Event

POC: WILL JOHNSON

On April 28, NASA Technology Day on the Hill was held at the United States Congressional Cannon Building in Washington, D.C. The event was organized by NASA Headquarters for members of Congress and their staff to showcase key NASA technologies under development. The Air Traffic Management Technology Demonstration 1 (ATD-1) SubProject was selected by NASA's Aeronautics Research Mission Directorate for the event to highlight the avionics technology and associ-

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ated fiscal year 2017 flight test being developed with industry partners.

SubProject Manager for ATD-1 William C. Johnson and a senior representative from Boeing Research and Technology were on hand to discuss the value of all of the ATD-1 technologies and highlight NASA's private sector collaboration. The event was attended by hundreds of visitors, including many Congressional members and staff, the NASA Administrator and Deputy Administrator, and several NASA senior executives.

FFC Projector Upgrade

POC: FAY CHINN

With installation of 12 new Sony laser projectors in early May, FutureFlight Central (FFC) completed an extensive upgrade of a 360-degree, out-the-window view. The new projectors enable higher image resolution, a brighter picture, and digital input connectivity. The upgrades feature:

- Direct projection, replacing the mirrored rear projection system of the previous projectors, which, due to their age, were starting to produce warping of the visual image, alignment problems between windows, and poor picture quality;
- A mean time between failure of 20,000 hours (with the auto light dimming function enabled), as well as enhanced brightness and color stability over time. The new projectors should last for 10 years of normal FFC use without significant recurring maintenance cost; and
- A laser diode light source that is more efficient because of less light lost, and is more environmentally friendly compared with the former mercury lamp-based projection systems.

The new projector system will enable FFC to more accurately portray out-the-window visual scenes at airports such as North Carolina's Charlotte Douglas International Airport, the test site for upcoming ATD-2 tests and demonstrations.

ATD-2 User Meeting at AA Training Facility

POC: AL CAPPS

On May 3-4, members of NASA's Airspace Technology Demonstration 2 (ATD-2) Team met ATD-2 system users at the American Airlines (AA) training facility at Charlotte Douglas International Airport (CLT) in North Carolina. FAA (FAA) participants included representatives from the en-route facilities in Washington, D.C. and Atlanta, Charlotte air traffic control towers, the Charlotte Terminal Radar Approach Control (TRACON), and FAA headquarters organizations for NextGen (ANG), Mission Support (AJV), System Operations (AJR), Program Management Organization (AJM), and the FAA's Southern Region Office.

AA ramp tower and CLT airport participants from the local Charlotte operations were also in attendance. NASA presented ATD-2 background information, including foundational FAA technologies, NASA and FAA research, and the phased ATD-2 development and demonstration plan. NASA briefed the attendees on the status of ongoing work, including the Phase 1 Concept of Use, the notional time-based flow management (TBFM) deployment plan, the desired training model and the proposed ATD-2 process and quality checkpoints. The user meeting led to a number of productive interchanges among the multi-disciplinary, multi-organizational team.

In addition, two other major accomplishments were achieved May 4-5, demonstrating connectivity to the CLT laboratory space used by NASA for ATD-2 testing and evaluation. NASA's integrated communication services (NICS) wide area network was successfully connected to equipment in the NASA rack at CLT's shared tenant space, which will supply the necessary system-wide information management (SWIM) data feeds and other critical system interfaces that will support ATD-2. Network connectivity to NASA's CLT lab in the CLT Airport's Old Terminal was also verified, which

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ATD-2 User Group Meeting participants.

will be used to support shadow evaluations, training and demonstrations in the laboratory space.

On May 6, ATD-2 personnel participated in the FAA Advanced Electronic Flight Strips (AEFS) kickoff meeting at CLT Tower/TRACON. AEFS deployment is an element of the Terminal Flight Data Manager early implementation of Electronic Flight Data, which is a key component of the overall Integrated/Arrival/Departure/Surface Solution. The FAA is deploying AEFS to CLT earlier than originally planned to support the ATD-2 field demonstration.

During the meeting, the groups established general dates by which the installation, adaptation, training and operational use of the system would transpire, and enabled productive dialog between the relevant parties.

NASA Langley Hosts ATD-1 Avionics Phase 2 CDR

POC: SHERI BROWN

On May 5, NASA Langley Research Center hosted the Boeing Company's Critical Design Review (CDR) meeting in support of the $10.9 million, two-year flight-critical safety research contract task award entitled "Air Traffic Management Technology Demonstration 1 (ATD-1) Avionics Phase 2."

The Boeing-led team provided a presentation facilitating the review and discussion of the detailed design for the aircraft selection and proposed modifications, the avionics system hardware, software and system design, and the flight test plan. Presentation topics included system design, hardware components, software design, internal control documentation, a system test plan, identified aircraft, a test aircraft integration plan, schedule, risk assessment, mitigation plans, the change control process, configuration management, the quality assurance process, bill of materials, mounting locations for each aircraft, and an assessment of required system resources (e.g., memory, processing, power, interfaces) to accommodate the flight deck interval management (FIM) application.

The meeting was attended by a total of 60 individuals, including 10 remote participants and 32 travelers, representing leadership, engineers, researchers, and FAA stakeholders. NASA Langley leadership included the center's Aeronautics Research Directorate director and deputy director; the Research Directorate chief engineer and airworthiness and safety review board chair; and the Engineering Directorate associate director of aeronautics. All review board members passed the CDR with actions, giving the Boeing-led team authority to proceed with integration and test of the ATD-1 avionics prototype FIM system.

The Review Board opted to defer assigning all of the actions discussed during the meeting until after internal consideration and alignment with the statement of work deliverables. All actions are expected to be closed prior to the system acceptance review tentatively planned

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for December 2016. The ATD-1 SubProject manager expressed his personal satisfaction with the presentation, and with how the team discussion relieved major concerns.

Langley's Denise Scearce is the ATD-1 avionics lead and technical point of contact for the Phase 2 task.

DFW Board Chairman and Colleagues Visit NTX

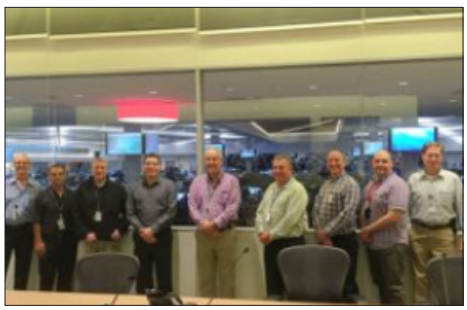
POC: PAUL BORCHERS

Dallas-Fort Worth International Airport (DFW) Chairman of the Board of Directors Mr. Sam Coats toured the NASA North Texas Research Station (NTX) on May 10. Accompanying Mr. Coats was DFW Executive Vice President of Operations Jim Crites and DFW Vice President of Environmental Affairs Robert Horton. After receiving an NTX overview and its past and present projects, Mr. Coats visited the NTX laboratory to observe repeater displays of NASA systems used by local FAA facilities. He was also briefed on the Airspace Technology Demonstration 2 Project, which is focused on improved integrated arrival/departure/surface operations, and was shown displays running with live data from Charlotte Douglas International Airport in North Carolina. The visit concluded with a presentation on novel surveillance research conducted at NTX, which provides a low-cost way of determining aircraft departure status at airports that lack surface surveillance systems. The presentations highlighted the cooperative work of government agencies, airlines and airports in enabling successful field demonstrations.

ATD-U at NTX

POC: AL CAPPS

On May 17-18, Airspace Technology Demonstration 2 (ATD-2) stakeholders from the FAA (FAA), the National Air Traffic Controllers Association, American Airlines (AA), DTIS Corporation and NASA personnel met at NASA's North Texas Research Station (NTX) for the fourth Airspace Technology Demonstration (ATD-U) class offering. During the two-day gathering, the group was briefed on the foundational technologies upon which ATD-2 is built and what it will attempt to achieve. The subject matter expertise of the attendees enabled further discussions regarding FAA software,



including Terminal Flight Data Manager, Advanced Electronic Flight Strips, and Surface Collaborative Decision Making. The FAA's D10 Terminal Services Manager Greg Juro led the group on a tour of the Dallas-Fort Worth International Airport Center tower, while the AA's Charlie Mead led ATD-U participants in a tour of the new AA Integrated Operations Center and elaborated upon its operations.

Visit from ENAC Professor Delahaye

POC: BANAVAR SRIDHAR

On May 16-20, Dr. Daniel Delahaye from the Ecole Nationale de l'Aviation Civile (ENAC) – ENAC is a major contributor to aviation research in Europe – visited NASA Ames Research Center. Dr. Delahaye heads the ENAC Optimization and Automatic Control Group and the Laboratory in Applied Mathematics, Computer Science and Automatics for Air Transport in Toulouse, France. The work of Prof. Delahaye's team has been applied to air traffic management (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.

Prof. Delahaye met with NASA Ames Senior Scientist for Air Trans-

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portation Systems Dr. Banavar Sridhar to discuss possible collaboration in developing efficient routes for long-haul flights and minimal noise approaches to airports, using optimization and data mining methods. NASA and ENAC are in the process of developing a collaborative agreement in ATM. Prof. Delahaye also received briefings on NASA's current work on the Shadow Mode Assessment Using Realistic Technologies for the National Airspace System Project Test Bed, and the Unmanned Aircraft Systems in the National Airspace System Project.

AOSP Showcased at Tech Center Exhibit

POC: JANE THIPPHAVONG AND TOM PREVOT

Research conducted by NASA's Airspace Operations and Safety Program (AOSP) was showcased during the annual Air Traffic Control Association (ATCA) Technical Symposium's Tech Center Tuesday event held on May 17 at the FAA's (FAA) William J. Hughes Technical Center in Atlantic City, N.J. The AOSP's Airspace Technology Demonstration 2 (ATD-2) Subproject departure metering capabilities were exhibited alongside the Unmanned Aerial Systems (UAS) Traffic Management (UTM) technologies. The ATD-2 materials featured a newly produced animation highlighting the ATD-2 concept and

Exhibit at the ATCA Technical Symposium's Tech Center Tuesday Event.

field demonstration plan. Exhibit visitors included government and industry representatives attending the ATCA Technical Symposium. ATD-2 received considerable interest throughout the event.

The UTM display featured a simulated scenario of traffic at the six FAA UAS test sites, plus simulated traffic from the San Francisco Bay Area. Visitors viewed functions of the UTM research platform on three iPad apps running Insight-UTM, the UTM research visualization app, and on a display showing selected UAS in a Google Earth environment.

Visitors to the NASA exhibits included Ed Mercer, director of the FAA's Interagency Planning Office (formerly the Joint Planning and Development Office), which guides consensus and investment decisions for the Next Generation Air Transporation System (NextGen); ATCA Manager for Air Traffic Control Programs Paul Plantzer; and former FAA Associate Administrator for NextGen Vicky Cox.

PTM Leads HITL Testing Activities

POC: DR. JENNIFER KIBLER

On May 24-26, the Pairwise Trajectory Management (PTM) Team conducted three single-day focus group assessments and human-in-the-loop (HITL) testing activities with commercial airline pilots. The primary purpose was to evaluate the effectiveness of PTM pilot training materials; however, important feedback regarding the PTM concept, proposed flight crew procedures, and airborne human-machine interface (HMI) prototype was also collected. A total of 12 active pilots with recent experience flying oceanic routes completed PTM computer-based training (CBT) modules prior to their arrival at NASA Langley Research Center in Hampton, Va.

During each focus group assessment, four pilot participants received instructor-led PTM training, critiqued the PTM CBT and instructor-led training materials, and engaged in HITL testing by flying a series of PTM scenarios using a medium-fidelity desktop simulator. After completing simulated PTM flight operations, the pilot participants provided additional feedback

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regarding the PTM training materials and shared detailed comments pertaining to the PTM concept, flight crew procedures, and HMI. PTM team members will use the pilot participants' feedback to develop a refined set of standardized training materials that will be used to prepare oceanic pilots for participation in an upcoming PTM HITL experiment. Additionally, pilot participant feedback will be considered during successive refinements of the PTM concept, flight crew procedures, and HMI design. The PTM team conducted the oceanic pilot focus group assessments and HITL testing activities, and are planning a PTM HITL experiment that will be conducted at NASA Langley during fiscal year 2017.

PTM Team Seeks Stakeholder Buy-in

POC: DR. JENNIFER KIBLER

A series of meetings were conducted with the various stakeholder groups in regards to NASA Langley Research Center's pairwise trajectory management (PTM) research activities. On May 18, Dr. Jennifer Kibler and Ryan Chartrand from NASA Langley, along with Ken Jones of the National Institute of Aerospace (NIA) met with members of the Air Line Pilots Association (ALPA) at ALPA Headquarters in Herndon, Va. The advanced-interval management (A-IM) PTM concept, and proposed PTM flight crew procedures and PTM benefits, were discussed. Additionally, a demonstration of NASA Langley's airborne PTM human-machine interface (HMI) design was also presented. ALPA was invited to provide feedback regarding the PTM concept, flight crew procedures, and HMI design, and a follow-on meeting was discussed.

Future meetings between the PTM team and ALPA will likely involve members of the National Air Traffic Controllers Association and the FAA's (FAA) Surveillance and Broadcast Services Program Office to ensure that the multi-faceted aspects of the air/ground system associated with PTM operations are appropriately considered.

On May 23, the NIA's Dr. Victor Carreño presented a paper on the A-IM PTM concept to the International Civil Aviation Organization Separation and Airspace Safety Panel, the international body that develops and approves new international aviation separation standards. That meeting was held in Reykjavik, Iceland.
On May 31, Dr. Kibler and Mr. Chartrand, along with Ken Jones and Tom Graff from the NIA, conducted a kickoff Skype meeting and telecon with members of the FAA's Oceanic/Offshore Standards and Procedures Group, AJV-84. The AIM-PTM concept as well as proposed PTM oceanic controller and flight crew procedures were discussed, as well as a brief demonstration of NASA Langley's airborne PTM human-machine interface design. AJV-84 oceanic controller subject matter experts (SMEs) were invited to participate in the development and evaluation of the PTM concept, oceanic controller procedures, and ground-based automation computer-human interface design.

Follow-on ground-oriented PTM concept discussions have begun taking place, and AJV-84 SMEs have agreed to provide feedback regarding the PTM Operational Services and Environment Definition (OSED) document that the NASA PTM team is currently drafting for RTCA Special Committee 186 Working Group 4. The OSED writeup contains a description of the PTM concept and operational requirements, and is necessary for the development of internationally harmonized PTM standards. Members of the PTM team were scheduled to hold a technical interchange meeting with the manager and members of AJV-84 in Washington, D.C. on July 11.

As a follow-on, the PTM team was expected to hold a technical interchange meeting with the FAA's A-IM leadership at NASA Langley

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on June 27. The alignment of the A-IM and PTM development and evaluation schedules were slated to be discussed, as was the coordination of a NASA/FAA Interagency Agreement.

AOSP's TCs Economic Value Assessed

POC: YURI GAWDIAK

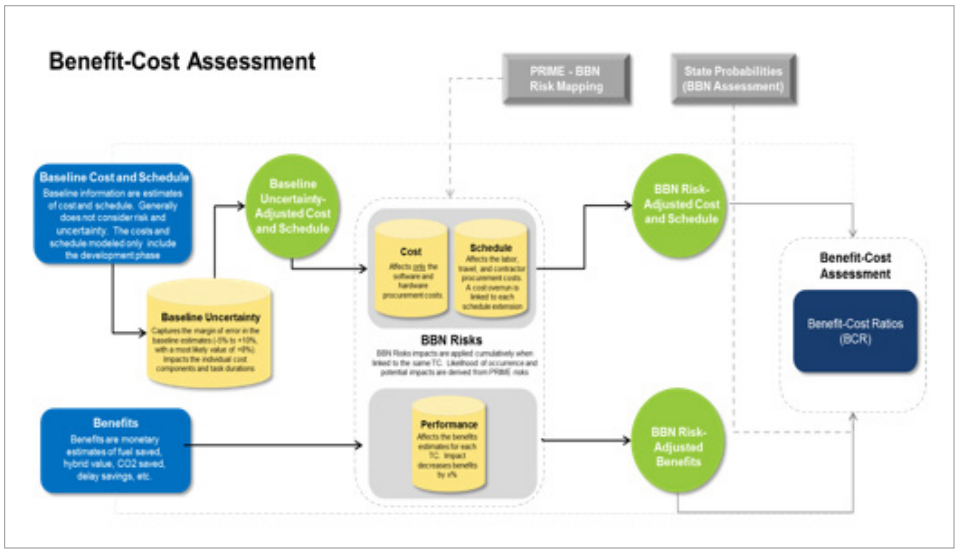
On June 6, Booz Allen Hamilton presented a report at NASA Headquarters to Airspace Operations and Safety Program (AOSP) management regarding the economic value of each of the 10 AOSP technical challenges (TCs) selected during initial reviews. The benefit-cost assessment compared benefit estimates for each of the 10 TCs under AOSP's three major projects projects with their corresponding development costs, adjusted by the impact of risks previously identified by the project team. The results of the assessment were presented as benefit-cost ratios of the discounted benefits and costs of each TC, which can be interpreted in terms of the maximum number of times of additional expenditure to implement the TC while still enabling the stakeholders to reap benefits from it.

The benefits of the TCs exceeded their development costs by a magnitude of two at the least. Significant variability across TC ratios was exhibited with Unmanned Aerial Systems Traffic Management showing the largest benefit-cost ratio: in excess of 2,000 times the development costs.

TASAR Partnership Advances

POC: DAVID WING

A kickoff meeting held at Virgin America Headquarters in Burlingame, Calif. on June 9 to mark a Space Act Agreement between NASA and Virgin America regarding the Traffic Aware Strategic Aircrew Requests (TASAR) Project advanced toward technical implementation. The NASA/Virgin America partnership will test the TASAR Traffic Aware Planner (TAP) software in operation on revenue flights.



NASA team attendees included NASA Langley Research Center engineers David Wing and Dr. Kelly Burke, Anna Noe, and contractors Bob Vivona, Jeff Henderson and Brendan Lefebvre from the Engility Corporation. Virgin America attendees included representatives from Virgin's flight operations, flight technical engineering, dispatch, flight operations quality assurance, and pilot training areas. Vendors for Virgin America also attended and included Astronautics, provider of electronic flight bags that will host the TAP software; Schneider Electric, provider of weather data; Honeywell, provider of a traffic surveillance system and onboard weather radar; and ViaSat, provider of Internet connectivity.

The group discussed a breadth of detailed technical topics related to system and operational integration, all critical for charting the implementation of TAP on an initial A320 aircraft in early-to-mid 2017. The System Integration Session addressed the target system architecture, data inputs, wiring and

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certification requirements, software installation and data retrieval requirements, bench testing, and the planned four-stage deployment plan. The Operational Integration Session addressed dispatch integration, data sources for convective weather and turbulence, data collection and analysis, and pilot training.

A high-level target schedule was proposed, and will be adjusted as information is gathered on pacing items such as wiring-installation certification, aircraft installation availability, and software readiness. The successful meeting generated interest and momentum that will be leveraged to move forward on many simultaneous fronts to enable operational testing of TASAR on Virgin America revenue flights.

Sherlock ATM Data Warehouse Covers Entire U.S. Airspace

POC: MICHELLE ESHOW

As of June 13, in a first for NASA, NASA Ames Research Center's Sherlock Air Traffic Management (ATM) Data Warehouse now produces analysis-ready, end-to-end track and flight plan data for the entire United States national airspace system (NAS). This significant accomplishment will enable ATM researchers to query flight information at the highest possible resolution, from a clean dataset that spans all known U.S. track locations for any individual flight. The processed data merges actual flight plan and track records from 77 different FAA (FAA) facilities, including 20 centers, 27 terminal radar approach controls, and 30 airport surface areas.

The Sherlock team overcame many challenges in correlating and rationalizing data from 77 different FAA feeds that may have overlapping and conflicting positions, flight plans, time, and airspace references. Currently, Sherlock has three months of this merged data available. Over the next several months of processing, data going back to 2011 will be processed and added. Current data is processed overnight for rapid availability. All the data is being added to the Big Data System for ease of analysis.

This work was enabled by a subcontract to ATAC Corporation, funded by the Shadow Mode Assessment Using Realistic Technologies for the National Airspace System Project.

NASA/FAA TBFM Integration Strategy Meeting

POC: JANE THIPPHAVONG

On June 16, in Washington D.C., to discuss terminal flight data management (TFDM) integration strategy for field demonstrations, the NASA Airspace Technology Demonstration 2 (ATD-2) team met again with representatives from the National Air Traffic Controllers Association; personnel from the FAA (FAA) Office of NextGen; those from the FAA involved in TFDM, time-based flow management (TBFM), mission support and system operations; and Lockheed Martin staff.

NASA proposed integrating the ATD-2 surface system (TFDM stand-in) with the operational TBFM Integrated Departure Arrival Capability web services routing tool capability to enable demonstration of 3T (TBFM, TFMS, and TFDM) integration in the field. The proposal gained support to proceed with more detailed planning of the software changes required for TBFM release 4.7, scheduled for spring 2017. Follow-on meetings to discuss testing procedures, security requirements and the FAA/NASA network architecture to support the proposed strategy are in progress.

CLT ATD-2 Lab Ribbon Cutting Ceremony

POC: SHAWN ENGELLAND

On June 24, U.S. Department of Transportation (DOT) Secretary Anthony Foxx and NASA Administrator Charles Bolden were joined by representatives from the FAA (FAA), the National Air Traffic Controllers Association (NATCA), American Airlines (AAL), and the Charlotte Douglas International Airport (CLT) for a ribbon cutting event, celebrating the official opening of the new Airspace Technology Demonstration 2 (ATD-2) Subproject Laboratory at CLT.

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS

Ribbon Cutting Ceremony at CLT lab with NASA Administrator Charles Bolden.

"Today is a great moment for the city of Charlotte, for air travelers, and our environment," said Secretary Foxx. "As a son of this city and this state with its special history with modern flight, I'm thrilled that Charlotte Douglas International Airport is at the forefront of this innovative partnership between DOT and NASA that will have a transformative and lasting impact on aviation." ATD-2 is designing new scheduling tools and integrating them in current FAA systems to provide a coordinated plan that controllers, planners and managers can all use for all phases of flight. The CLT lab is the first external installation of NASA's ATD-2 technologies outside the existing NASA laboratories. Beginning in mid-July, the CLT lab will provide a collaboration space for working with air traffic controllers and airline operations to develop technologies and conduct evaluations. The NASA technologies will move into operational facilities beginning September 2017 and be evaluated over next three years.

The event is depicted in the following NASA press release: http://www.nasa.gov/press-release/transportation-department-nasa-partners-visit-charlotte-to-open-test-lab-to-streamline

ATD-1 Participates in European IM Kickoff

POC: WILL JOHNSON

On June 29-30, the European Knowledge Development Center (KDC) Interval Management (IM) Project flight test planning kickoff meeting was held in Amsterdam, the Netherlands. The KDC IM Project is planning a series of flight tests in Europe to evaluate the performance of IM to inform future Automatic Dependent Surveillance – Broadcast investment decisions there.

The KDC IM Project members include the Netherlands Aerospace Centre (NLR), EUROCONTROL, the Netherlands Air Navigation Service Provider, Schiphol Airport, KLM Airlines, Technical University Delft, Rockwell Collins, The Boeing Company, and NASA. William C. Johnson, Air Traffic Management (ATM) Technology Demonstration 1 (ATD-1) Sub-Project manager and NASA representative to the KDC IM project, presented ATD-1 flight testing status, avionics interface design, and flight test data-collection plans.

NASA is participating in the KDC IM project by providing the IM algorithm for this flight test activity and subject matter expertise through a Space Act Agreement between NASA and NLR. The next meeting is expected to occur in November when both NASA and the other KDC members have devised initial plans for 2017.

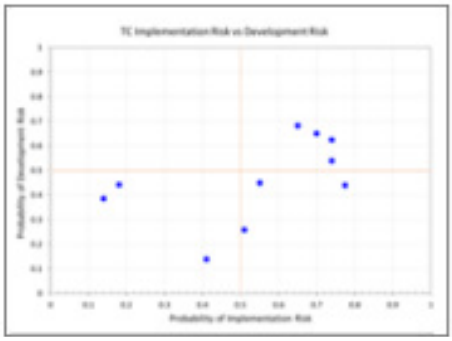
AOSP TC Risk Analysis Update

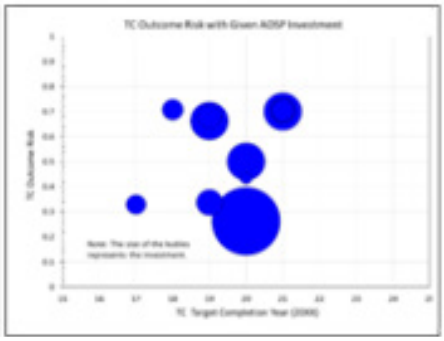
POC: ANN T. SHIH

The Bayesian Belief Network (BBN) approach has been applied to assess the probability of the Airspace Operations and Safety Program (AOSP) to meet/not meet expected outcomes for the AOSP technical challenges (TCs). The TCs-risk BBN is a probabilistic graphical model, taking into account the different risk factors of technology development and implementation.

The model not only provides understanding on how the TCs outcome risk is dependent on uncertainty of risk factors in the model, but also gives insight of the risk drivers via sensitivity analysis. The BBN risk modeling provides

TECHNICAL AND PROGRAMMATIC HIGHLIGHTS





a consistent and transparent process in evaluating the current 10 TCs in the AOSP portfolio.

A third round of TCs-risk BBN analysis was recently completed with risk probability inputs from project staff. The recent analysis results were compared to previous results generated with inputs from the TC leads and AOSP Portfolio Systems Analysis Team (APST) members.

The comparison reveals that there are different risk projections from three input groups with their respective understanding and perspective. In addition, risk items in the prime risk registry for each TC were examined for risk categorization, and statistics of risk status, duration and impacts. Some inconsistent trends between registered risk data on the prime and TCs-risk BBN results were found. All these results and findings were presented to AOSP program/project offices, and its risk management board for discussion and resolution.

PAPERS AND AWARDS

ATD-1 Case Study Presented at OSD/NASA Workshop

POC: WILL JOHNSON

Dr. Sara Wilson was invited to give a presentation at the Rigorous Test and Evaluation for Defense, Aerospace, and National Security Workshop in Arlington, Va. on April 11-13. This workshop was co-organized by NASA as an element of the Interagency Statistical Engineering Agreement between the NASA Office of Chief Engineer and the Director, Operational Test and Evaluation in the Office of the Secretary of Defense (OSD). Her presentation entitled "Human-in-the-Loop Experimentation for the Next Generation Air Transportation System" described a case study from NASA's Air Traffic Management Technology Demonstration 1 (ATD-1) and highlighted statistical challenges.

NASA Multicopter Research Recognized by AHS

POC: JAEWOO JUNG

Published aircraft performance data for multicopter unmanned aerial system (UAS) vehicles, such as quadcopters and octocopters (often referred to collectively as drones), are currently lacking. With the rapidly increasing popularity of such vehicles, researchers, system designers and operators need to develop better models to accurately predict performance and model trajectories. To collect such performance data, a joint wind tunnel test was conducted in winter 2015 in the U.S. Army's 7-Foot by 10-Foot Wind Tunnel at NASA Ames Research Center.

Three NASA aeronautics programs participated in this test: The Airspace Operations and Safety Program's (AOSP) UAS Traffic Management (UTM) Subproject, the Transformative Aeronautics Concepts Program's Design Environment for Novel Vertical Lift Vehicles Subproject, and the Advanced Air Vehicles Program's Revolutionary Vertical Lift Technology (RVLT) Project. Five multi-copter UAS vehicles were tested: 3D Robotics' SOLO and Iris+, DJI's Phantom 3 Advanced, Drone America's DAx8, and Straight Up Imaging's Endurance. Data were collected on forces and moments, as well as electrical power as a function of wind speed, rotor speed and vehicle attitude.

The initial results were presented during the American Helicopter Society (AHS) International's 72nd Annual Forum at West Palm Beach, Fla. On May 16-19. The Multicopter UAS Wind Tunnel Test Team's work, with contributions from researchers within AOSP and the Aeromechanics Office at NASA Ames, was also recognized with the Franklin Award for Outstanding Contribution to the Powered-Lift Field by the San Francisco Bay Area Chapter of AHS International. The award citation read: "For successful planning and execution of the first wind tunnel test performed to acquire experimental data for performance and acoustics of five multicopter unmanned aircraft systems in the the U.S. Army's 7-Foot by 10-Foot Wind Tunnel."

UTM Wind Tunnel Test Team.

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