FY22 ACHIEVEMENTS IN AEROSPACE AND TRANSPORTATION

CENTER FOR ADVANCED AVIATION SYSTEM DEVELOPMENT
THE MITRE CORPORATION

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CAASD
Annual Report

FY 2022

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Letter from Kerry Buckley

The year of 2022 was one of change. From a return to near normalcy from COVID to leadership changes across the FAA and MITRE—including my own as I stepped into the Vice President role for the Center for Advanced Aviation System Development (CAASD). With change though comes challenge and opportunity, and CAASD is leaning into those opportunities as we look to the future.

This annual report highlights a year of impact in 2022. From closing out Metroplex—one of our longest and most successful partnerships, to helping set the vision in the FAA's Charting Aviation's Future, CAASD continues to serve as your strategic advisor, innovation partner, integrator, and system-of-systems engineer.

In addition to a retrospective of key achievements, we also offer a look ahead at the important work to come: accelerating the FAA's vision for an info-centric NAS through an automation evolution strategy and architecture; integrating new capabilities and new entrants to ensure operational efficiency and optimization; realizing the next level of safety across the aviation community; and transformative research to test future concepts.

Our works spans surface to space, so we harness all of MITRE on cross-cutting challenges like cyber, commercial space, civil-military integration, international aviation, and automation across the entire transportation domain in support of the FAA. As we look to the future, we are focused on what a holistic, intelligent, and people-centric system looks like: equitable, resilient, and sustainable.

The only constant is change, and in 2023, we are looking at how we evolve the Aviation Safety Information Analysis and Sharing (ASIAS) program; we are preparing to support FAA priorities in reauthorization; and we look forward to welcoming a new FAA Administrator. To help drive national-level decisions and actions, we focused on serving as a connector while also investing in fully immersive modeling and simulation capabilities to solve system-of-systems challenges in collaboration with government, academia, and industry. The challenges are infinite, but I am confident that we are ready for them.

It is our privilege to serve as your trusted mission partner, and I look forward to continuing our joint legacy of innovation as we pioneer together to ensure the safest, most efficient aerospace system in the world.

Dr. Kerry Buckley

Vice President and Director,
Center for Advanced Aviation
System Development (CAASD)

The MITRE Corporation

INTRODUCTION

In 1990, the Federal Aviation Administration (FAA) established its federally funded research and development center (FFRDC) to perform the advanced research and development needed to modernize the National Airspace System (NAS). As an FFRDC, the Center for Advanced Aviation System Development (CAASD) provides the FAA with advanced scientific and engineering technical capabilities in areas such as systems engineering, mathematics, and computer science, while applying in-depth aviation domain knowledge of Air Traffic Management (ATM), airspace operations, and aviation stakeholders relevant to the NAS and global aerospace operations.

To meet this need, the FAA has invested in the unique laboratories, modeling, simulations, and analytic capabilities at CAASD that are used to evaluate concepts and improvements to current and future systems and operations. These assets help the FAA and aviation stakeholders agree on changes and envision future integrated operations.

As an independent organization, CAASD provides objective analyses and recommendations. It is an essential FAA resource because of its in-depth ATM operational knowledge, institutional memory, and extensive analysis capabilities developed over many years of FAA support. Such long-term relationships are a hallmark of FFRDCs—enabling extensive knowledge and capability development that could not be as effectively created or applied through competitive procurement. This combined knowledge and capability enables CAASD to address difficult issues that require multiple disciplines, special studies, and functional specialties and that are too broad or complex for other organizations to address in a manner as timely or as cost-effectively.

FFRDCs are owned by the federal government but operated by contractors, universities, non-profit organizations, and industrial firms. CAASD is currently operated by The MITRE Corporation, a not-for-profit company that operates multiple FFRDCs serving both public and national security sectors. MITRE has worked continuously with the FAA since 1959 to improve the United States (U.S.) and global air transportation system.

Our contract and Sponsoring Agreement outline the expectations our FAA sponsor has of us, including:

- Embrace the FAA's mission
- Partner at the Agency and Administrator level
- Align priorities with FAA priorities
- Provide unbiased advice and technical expertise
- Drive innovation across FAA and stakeholder community
- Continually evolve to anticipate FAA needs.

In addition, the FAA has explicitly outlined four key roles we must fulfill as its FFRDC:

- Strategic Advisor
- Innovation Partner
- Integrator
- System-of-Systems Engineer.

These four roles are the foundation upon which we plan, execute, and review our work with the FAA.

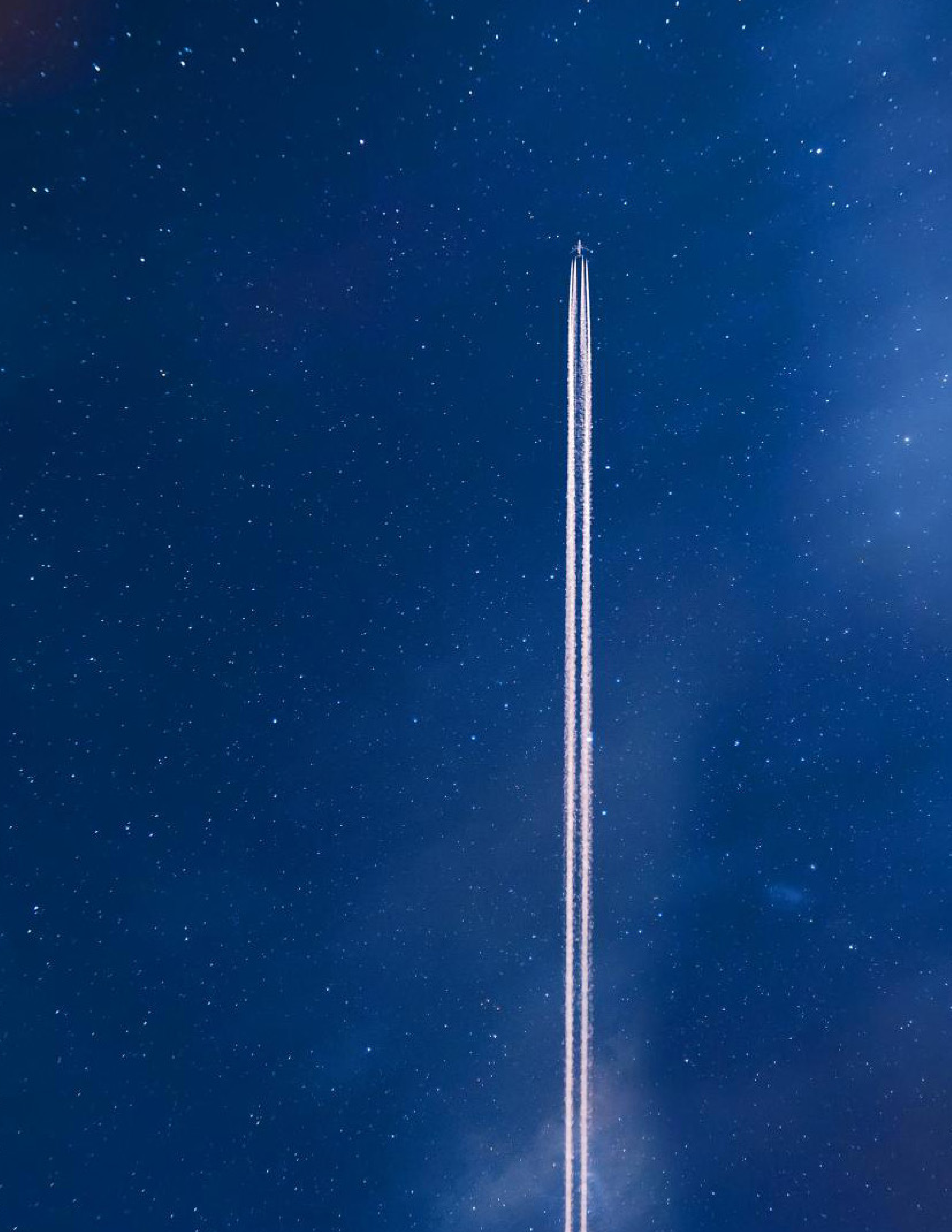
With the approval and support of the FAA, CAASD also collaborates with civil aviation authorities around the world, all of which face similar challenges in the areas of safety, security, and efficiency. The FAA encourages CAASD's relationships with these organizations to increase knowledge of best practices in aviation, advance international harmonization of aviation and Air Traffic Control (ATC) standards and technology, and share information with the FAA and other stakeholders.

As aerospace and transportation evolve and expand to include multiple modes on the surface and into space, CAASD has expanded its capabilities to prepare for these future challenges. From commercial space launch, new entrant integration, surface transportation systems safety, and civil-military integration, CAASD works in conjunction with other MITRE FFRDCs to bring knowledge and sponsor relationships to bear on the toughest cross-domain, cross-government challenges.

The next sections outline highlights of CAASD's Fiscal Year 2022 (FY22) mission accomplishments, provide an overview of plans for FY23, and offer a longer-term outlook for the years ahead. The sections are organized by outcomes, as outlined in the Product Based Work Plan that the FAA and CAASD create each fiscal year:

- Outcome 1: NAS Concept of Operations, Architecture, and Integration
- Outcome 2: ATM Operational Evolution
- Outcome 3: Airspace and Performance-Based Navigation
- Outcome 4: Safety and Training
- Outcome 5: Communications, Navigation, Surveillance, and Cybersecurity Infrastructure
- Outcome 6: Unmanned Aircraft Systems
- Outcome 7: Special Studies, Laboratory, and Data Enhancements
- Outcome 8: Mission-Oriented Investigation and Experimentation.

Subsequent sections provide details on CAASD innovations and accelerators; governance and operations of the FFRDC; and financial and staffing performance data.



FY22 MISSION ACCOMPLISHMENTS, PLANS, OUTLOOK

OUTCOME

01

NAS CONCEPT OF OPERATIONS, ARCHITECTURE, AND INTEGRATION

FAA Outcome Manager: Mr. Steve Bradford

CAASD Outcome Leader: Stephane Mondoloni

Outcome Statement: A transformed NAS and Next Generation Air Transportation System (NextGen) that:

- Meets national goals for the safe and efficient delivery of air transportation services.
- Maximizes operational and cost efficiencies for the government, its customers, and its stakeholders.
- Positions U.S. aviation to meet national objectives and new entrant challenges and aligns government priorities and investments.

Highlighted Accomplishments

Florida NextGen Test Bed Demonstrations

The FAA's Florida NextGen Test Bed (FTB) provides an industry-accessible laboratory environment to experiment with future technologies and their integration into the NAS. The FTB enables the FAA and partners, including CAASD, to experiment with future concepts related to Trajectory-Based Operations (TBO), flight information management such as the Flight and Flow–Information for a Collaborative Environment (FF-ICE), and the Connected Aircraft.

The FAA and partners use these demonstrations to validate and influence relevant International Civil Aviation Organization (ICAO) guidance and FAA system development. CAASD specifically develops and maintains software prototype systems to provide core flight planning and filing capabilities at the FTB using both legacy and FF-ICE exchanges essential for demonstrating future concepts.

FY22 ACCOMPLISHMENTS: CAASD collaborated with the FAA and numerous industry and support partners to conduct experiments and demonstrations. The Multi-Regional TBO Phase 2A demonstration in the spring of 2022 showcased a variety of TBO capabilities across multiple international boundaries within a distributed laboratory setting. Participants and capabilities were distributed internationally with collaboration from FAA international partners, which included equivalent organizations from Canada, Japan, Thailand, and Singapore. Scenarios included flights operating within North America, across the Pacific, and between multiple Flight Information Regions (FIR) within Asia. TBO capabilities were demonstrated using the trajectory as a basis for collaborative planning prior to departure and replanning while in flight. In these demonstrations, CAASD-developed prototype systems were modified to integrate with oceanic automation systems and applied for trajectory-based collaboration through standards-based exchanges. This included the exchange of FF-ICE messages leveraging the Flight Information Exchange Model (FIXM). In addition, CAASD helped the FAA develop a simulated TBO capability to express the operational value across time from demonstrated capabilities.

FY23 PLANS: CAASD will continue to collaborate with the FAA and partners to conduct the Phase 2B Multi-Regional TBO demonstration in mid-2023. While Phase 2A provided an international laboratory demonstration, Phase 2B will incorporate a live trans-Pacific flight demonstrating TBO capabilities as part of operational scenarios within a live environment. The demonstration will showcase the interactions with the aircraft systems, leveraging the Connected Aircraft as a key enabler of TBO operational capabilities. Through the collaborative development, sharing, and execution of planned trajectories, TBO enables operational decisions to be more strategic than they are in today's environment. The live-flight demonstration will describe how a single flight will use certain TBO capabilities to make more strategic decisions. CAASD will apply those capabilities across many days, through a simulation, to better elucidate how certain operational value, such as predictability, can be obtained.

FY24–26 LOOK-AHEAD: CAASD will continue collaborating with the FAA and a wide range of partners across a range of demonstrations. Preparation and development work for these demonstrations help inform and validate international concepts, standards, and guidance in areas such as FF-ICE, TBO, and the Connected Aircraft. Through international collaboration, experience is gained across boundaries, providing shared knowledge to ease future implementations and facilitate interoperability.

Connected Aircraft

In 2022, the FAA published its vision for an info-centric NAS. The vision describes how the FAA will build on NextGen and identifies some key changes in three fundamental pillars. These pillars describe changes in Operations, Infrastructure, and Integrated Safety Management. Within the Infrastructure pillar, the Connected Aircraft describes capabilities to enable full participation by the flight deck within the ubiquitous information environment.

The Connected Aircraft provides the opportunity to leverage commercial services and non-aviation spectrum for information sharing with the flight deck, provided that performance levels are fit-for-purpose. The FAA has developed a Connected Aircraft Concept of Operations (ConOps) and has been working with ICAO expert groups to coordinate the development of further guidance and standardization.

FY22 ACCOMPLISHMENTS: The FAA has been collaborating with expert groups at ICAO toward international acceptance of a Connected Aircraft ConOps. CAASD has been working with the FAA and partners in the socialization and refinement of the concept. Validation of the concept has involved the inclusion of use cases involving the Connected Aircraft in a variety of tabletops and demonstrations. As these Connected Aircraft applications are defined, CAASD has helped to define alternative information exchanges. One such application is the exchange of aircraft-derived trajectory information through a connected Electronic Flight Bag (EFB) in lieu of providing the Extended Projected Profile (EPP) from certified avionics systems. CAASD conducted an evaluation of the exchange of information in a laboratory setting using avionics systems on a testbench. The approach was described in an information paper provided to the ICAO 41st Session of the Assembly on behalf of the United States.

FY23 PLANS: CAASD will continue to work with the FAA, its partners, and ICAO expert groups in the development of the Connected Aircraft Concept for ICAO, which is expected to be completed in 2023. CAASD will be investigating human factor issues that potentially arise from choices in implementation of the Connected Aircraft, such as the choice of display configurations. CAASD will also continue the investigation of the use of the Connected Aircraft to provide trajectory data to ground-based ATM applications. CAASD will evaluate the use of a figure-of-merit for quantifying the quality of the trajectories that may be obtained under a variety of possible Connected Aircraft configurations. CAASD will also investigate the use of the Connected Aircraft to address the quality of ground-based trajectories for ground-based problem resolutions. Together with the toolkit and siting guidance, a remote tower siting order will establish a repeatable and evidence-based approach for ensuring visibility that integrates well with other aspects of the remote tower approval process.

FY24–26 LOOK-AHEAD: The FAA will continue to validate the Connected Aircraft concept through laboratory and flight demonstrations of applications that are making use of the concept. The exchange of aircraft-derived trajectory information through the Connected Aircraft will be further specified leveraging the alternatives performance analysis being conducted in FY23. Methods for the use of the information by ground-based trajectory modelers will be tailored to the logical information sharing alternatives. With international agreement on the concept, the Connected Aircraft can also be leveraged to allow Traffic Flow Management (TFM) units to obtain up-to-date information from flights long before the flights enter an FIR's airspace without requiring additional communication between FIRs. Further, aircraft equipped with connected EFBs will develop novel internal applications leveraging any data that is available on the ground.

Mobile Based Information Exchange Services

As future ATM concepts emerge, it is important to consider the data exchange requirements between those capabilities and ATM automation systems. CAASD has been exploring multiple mobile technology-enabled concepts including Instrument Flight Rules (IFR) Clearance Delivery, Surface Taxi Routing and Conformance Monitoring, Departure Release Coordination, and other pre-departure information sharing capabilities. These concepts focus primarily on General Aviation (GA) aircraft and the pilot's ability to use their personal mobile device to exchange information with the FAA through a service provider, such as a mobile app provider.

Through a broad research portfolio that includes analysis, prototyping, and demonstrations, CAASD has been exploring and pioneering the methods for how these concepts will exchange messages and information in a manner that aligns with the FAA's future info-centric NAS.

FY22 ACCOMPLISHMENTS: In FY22, CAASD initiated a technology transfer of Pacer functionality to industry and executed a full licensing agreement with one app service provider. This represents an important milestone toward enabling broader pre-departure information exchange between GA and Business Aviation (BA) flight operators and the FAA using mobile technologies, notably for the communication of improved departure intent information.

During the year, CAASD also successfully

demonstrated the concepts of Mobile IFR Services and Call for Release Time Coordination through a real-time simulation in MITRE's Integration Demonstration and Experimentation for Aeronautics (IDEA) Lab, with the participation of active controllers. The findings and feedback obtained through this exercise are informing refinements to controller interfaces and system architectures, as well as the processes and procedures that will be needed to integrate these concepts into existing operations.

FY23 PLANS: CAASD plans to continue to collaborate with the FAA's architecture team to further explore and provide expertise toward defining how mobile concepts can be accommodated in the future flight information management architecture.

The CAASD team will also begin planning for an upcoming, integrated field demonstration that will involve multiple mobile concepts that were previously demonstrated in the lab. CAASD plans to refine and update controller interfaces based on lab demonstration feedback, and pilot interfaces through engagements with active, instrument-rated pilots. CAASD also plans to migrate the demonstration prototype to use live System Wide Information Management (SWIM) flight data in preparation for use in the field. Field demonstration planning will also include a site selection, identification of expected touchpoints with NAS systems, and safety planning preparations.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to encourage and support the proliferation of information exchange between the FAA and GA/BA flight operators through technology transfer and industry engagements.

Following site selection and preparations, CAASD will execute a field demonstration of mobile technology-enabled concepts that support broader information exchange among NAS users. The outputs of this field demonstration will validate information exchange architectures and controller-facing interfaces. The demonstration will also serve as a pathfinder for industry toward accelerating the integration of functionality into existing pilot-facing apps.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OUTCOME 02

ATM OPERATIONAL EVOLUTION

FAA Outcome Manager: Ms. Jacqueline Jackson and Mr. Rob Hunt

CAASD Outcome Leader: John Mayo

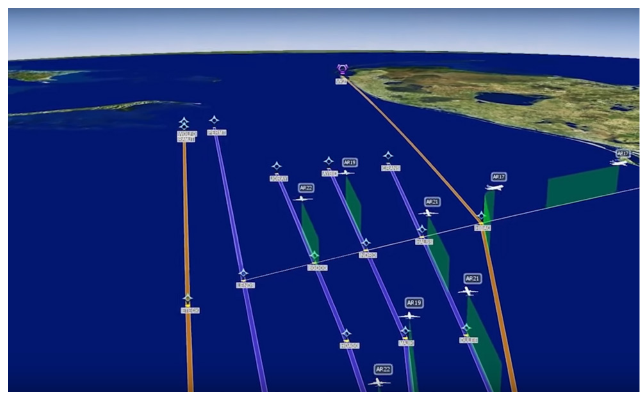
Outcome Statement: Evolve ATM into an efficient, collaborative, and cost-effective operation that over the next five to ten years:

- Improves operational safety, efficiency predictability, and productivity in the NAS, benefiting the FAA, all NAS operators, and the flying public.
- Enables more effective utilization, maintenance, and enhancement of system resources and capabilities (e.g., reduces the cost of ownership for FAA infrastructure and reduces controller workload).
- Improves the overall provision of air traffic services to users, accommodating access and flexibility under current and projected traffic volume, and integrates new entrants (e.g., commercial space vehicles, Unmanned Aircraft Systems [UAS], and balloons).
- Promotes the integration of the modernized TFM system with the evolution of en route modernization plans, terminal systems, and NAS-wide operations while increasing common situational awareness and collaborative decision making with ATM stakeholders.
- Leverages research and development advancements in aircraft and aviation technologies with particular focus on flight-deck advancements.
- Improves airspace access and national security.
- Demonstrates international leadership by promoting seamless operations around the globe.

Highlighted Accomplishments

Advanced Surveillance Enhanced Procedural Separation (ASEPS)

The FAA's ASEPS project has been investigating the use of Space-Based ADS-B (SBA) to increase operational efficiencies in FAA-managed oceanic airspace.



FY21 ACCOMPLISHMENTS: CAASD contributed to the development of the ASEPS solution-level ConOps for the FAA Joint Resources Council (JRC) Investment Analysis Readiness Decision (IARD), leading with technical and operational expertise in concept development and descriptions of future oceanic ATC capabilities enabled by SBA. These capabilities focus on providing additional oceanic operational efficiencies by leveraging enhanced surveillance. Other aspects of the ASEPS ConOps describe using SBA to enhance situational awareness in domestic airspace and the use of SBA archived data for analyses.

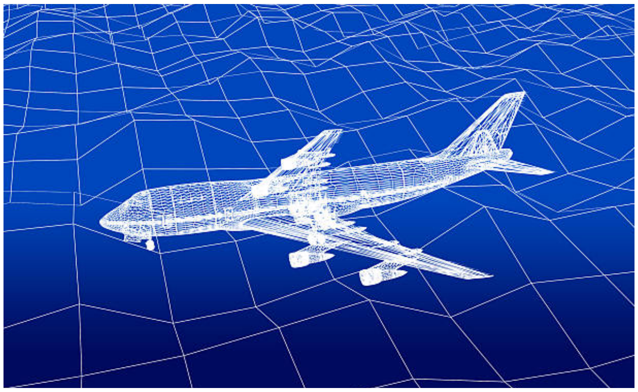
CAASD analyzed the performance of SBA reporting in FAA oceanic airspaces, primarily by measuring the probability of update interval against the relevant FAA thresholds that allow reduced oceanic separation. Part of this analysis focused on identifying and investigating common reasons for the existence of under-performing aircraft. CAASD also assessed the Automatic Dependent Surveillance–Broadcast (ADS-B) and antenna configuration equipage levels and data communications capabilities and qualifications of aircraft in these airspaces using the MITRE avionics equipage database and Advanced Technologies and Oceanic Procedures (ATOP) recorded data.

In September, with the JRC decision to suspend ongoing and planned ASEPS investment activities, CAASD pivoted to explore alternative market capabilities for this service. CAASD contributed technical and operational inputs to FAA's Request For Information to industry, including two attachments containing the ASEPS technical requirements and ConOps that will be published in FY23.

FY23 PLANS: CAASD will lead the development of an assessment approach and criteria for industry responses on the requested information. CAASD will also participate in those assessments and discussions of any FAA-funded activities that may follow.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to leverage extensive oceanic operational and systems engineering knowledge while providing data-driven analyses to the FAA.

TFM Predictive Analytics



The FAA has various decision support capabilities and descriptive analytics that are available to assist TFM operational planning and execution. The current TFM toolset's lack of capabilities to predict system performance has limited the ability of traffic management personnel to respond proactively and consistently to NAS constraints. To address this shortfall, CAASD has developed predictive models based on modern Artificial Intelligence (AI) and Machine Learning (ML) technology to predict the performance of airport operations, including projected delay trends and surface congestion.

To assess the potential benefits, select models have been deployed live by connecting real-time operational data and performing continuous predictions to support day-of NAS planning activities. Through an extended evaluation period, these models demonstrated the use of data-driven, learning-based prediction for TFM personnel to proactively act on problems of surface congestion and airport delay management.

FY22 ACCOMPLISHMENTS: In FY22, CAASD established the necessary data and IT infrastructure for the trained AI models to continuously ingest live data and perform prediction 24/7. CAASD also worked with the end users at the Air Traffic Control System Command Center (ATCSCC) to address the identified human-AI teaming challenges by iteratively improving AI result explainability, display transparency, and performance alerting functionalities. The operational feedback, observed benefits, and challenges of using predictive information for strategic and tactical TFM decision making were documented to inform future research on AI adoption for TFM.

FY23 PLANS: CAASD plans to continue working with the FAA to explore the applicable problem areas for predictive analytics, as Artificial Intelligence/Machine Learning (AI/ML) is envisioned to play an important role in an info-centric NAS. CAASD also plans to work with the FAA to have a designated organization to establish an environment for hosting TFM AI/ML applications and allowing for continuous data validation and continuous model re-training and deployment.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will engage the FAA to address the unique challenges of AI/ML that are different from traditional automation systems and thus research the principles or preliminary concept for human-AI teaming for NAS operations. CAASD will also explore with the FAA the technology transfer requirements for FAA to validate, acquire, operate, and sustain the capabilities that claim to embed AI/ML techniques.

CAASD developed models based on modern AI/ML technology to predict the performance of airport operations.

Automation Evolution Strategy

The FAA is challenged with reducing the costs of developing, operating, and sustaining NAS automation platforms. At the same time, to support its future vision for the NAS, the FAA must address new mission needs, technology opportunities, growing cybersecurity threats, and the scalability of information management capabilities. As a result, the FAA is seeking an approach that reduces the time to develop, integrate, and deploy new capabilities. To address this challenge, CAASD, working with FAA leadership, has initiated the implementation of an Automation Evolution Strategy (AES) that envisions a service-based architecture.

FY22 ACCOMPLISHMENTS: CAASD developed a Concept of Use (ConUse) that assists the FAA in identifying how organizational roles and processes may need to change in order to achieve and maximize the benefits of the future architecture. For industry engagement, CAASD collaborated with the SWIM-FAA Industry Team (SWIFT) to conduct a Developers Workshop series that consisted of three webinars and an in-person developer workshop hosted at MITRE where developers applied the concepts described in the AES ConUse to develop and deploy applications using SWIM data.

For transition planning efforts, CAASD defined an overarching transition approach for legacy systems that applies Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) models. CAASD's work with the FAA in planning to define, design, and manage a Mission Essential (ME) Operating Environment (OE) infrastructure for the NAS enterprise, including standard compute and platform layers of the software infrastructure, has been instrumental in providing the FAA enough information to commit funding to move forward with this ME-OE enterprise infrastructure. CAASD efforts included an assessment of existing orders to identify what changes may be needed to support the future architecture, as well as initial monitoring and management concepts for the various compute environments the FAA is considering.

Finally, CAASD worked the FAA's AES Acquisition, Budget, and Contracting team to define an AES Acquisition Strategy and Business Case approach that serves as a reference to align FAA stakeholders on the approach to fund, acquire, and manage enterprise platform and compute resources for use by NAS programs.

FY23 PLANS: CAASD will collaborate with the FAA to conduct specific automation system transition analyses that include:

- Time-Based Flow Management (TBFM): The TBFM analysis will demonstrate an approach for moving the legacy scheduling functions into an IaaS type environment using containerization. The analysis will also demonstrate how the TBFM Scheduling function and legacy algorithms can be made available to other systems both in the NAS and commercially as an example of a highly useful "Common Service."

- Standard Terminal Automation Replacement System (STARS): The STARS analysis will demonstrate a Database Management Software (DMS) proof-of-concept virtualized instance of STARS DMS application for use by Technical Operations personnel.

In addition to the above, CAASD will continue with implementation of the AES ME-Enterprise platform and compute Enterprise Infrastructure to include platform management, test and evaluation activities, as well as collaboration with industry in the form of technical interchanges that will address specific challenge areas for implementation of the enterprise infrastructure.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will work with programs on plans to develop their applications and services to make full use of the enterprise infrastructure in the context of a set of target common mission services to be shared across the NAS enterprise. CAASD will also work with decision support programs to develop, acquire, and implement common services and new mission services in alignment with the NAS reference architecture.

Enterprise Information Display System (E-IDS)

E-IDS will be the first FAA enterprise-level platform to enable Air Traffic Operations access to timely and accurate operational real-time and static information that supplements information provided on primary radar displays. In alignment with AES principles, E-IDS is being developed using a microservices-based architecture with modern data exchange mechanisms, communication systems, and streamlined technology advancements to improve NAS safety and efficiency to the FAA workforce.

FY22 ACCOMPLISHMENTS: CAASD performed independent assessments of the contractor's system requirements and software architecture in preparation for the August 2022 Critical Design Review. CAASD conducted assessments using the contractor's Model-Based Systems Engineering (MBSE) model on the MITRE Engineering Platform. In coordination with the FAA, CAASD provided human factors guidance to the contractor (including early user involvement events) for evolving E-IDS functionality and user interfaces to meet users' operational needs. CAASD conducted performance analyses on key areas of the system architecture to inform bandwidth and sizing. Leveraging MITRE's Software Quality Assurance Evaluation (SQAE) processes, CAASD conducted software quality analyses on early software development drops, focusing on the software architectural issues of reliability, stability, evolvability, portability, and maintainability. CAASD also provided independent assessments and inputs to test plans, procedures, and scenarios including the development of test tools to mitigate risk associated with E-IDS interfaces.

CAASD collaborated with E-IDS Test teams in coordination with multiple intra-FAA organizations in establishing the E-IDS lab at the FAA's William J. Hughes Technical Center (WJHTC), ensuring it has all the operational connectivity and networking in place for early system integration testing. CAASD coordinated with Enterprise Information Management (EIM) and other authoritative sources to ensure maturity of static data Application Programming Interfaces (API) to further reduce risk during software development. CAASD established the foundational framework for EIDS.FAA.GOV and its homepage, along with integration of the E-IDS implementation dashboard. Finally, CAASD continued to work with the FAA to explore opportunities for E-IDS to be a pathfinder for the evolution of other enterprise automation platforms to support wider information needs.

FY23 PLANS: CAASD will continue to partner with the FAA in the evaluation and adjudication of proposed requirement changes and/or enhancements to the contractor baseline through independent assessments and analysis of MBSE models. CAASD will provide analysis to identify and mitigate risks related to E-IDS implementation and will continue to conduct analyses related to software quality with future software development drops. CAASD will work closely with the FAA to develop a plan for the first Risk Reduction Demonstration. Additionally, CAASD will examine and apply key lessons learned and guidance from other programs to inform Phase 1 policies and procedure developments for Air Traffic, Data Administration, and Maintainers. CAASD will provide guidance on methodology, criteria, and a structure for field acceptance tests to facilitate evaluations for Air Traffic, Data Administrators, and Maintainers in en route and terminal domains. CAASD will expand assessments and analyses to reduce risk during software development and testing of the E-IDS SWIM service interfaces. Finally, CAASD will work with EIM to improve access and ingest processes to capture information needs for Phase 2.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to be the FAA's partner in execution of E-IDS phased implementation, providing guidance to the E-IDS design contractor throughout system development and performing risk reduction activities to inform contractor software design and development. CAASD will continue to ensure the development meets requirements and mitigate risks to support Factory Acceptance Test, Development Test, and Operational Test.

CAASD worked with the FAA to explore opportunities for E-IDS to be a pathfinder for the evolution of other enterprise automation platforms.

Targeting and Addressing Prioritized NAS Efficiency Challenges

The NAS is a complex, integrated network serving many stakeholders seeking to prioritize resources for competing objectives. Execution of the NAS operation is accomplished through extensive, interconnected processes and procedures, information, and air traffic models and systems that seek a collaborative approach to optimize resource, market, and system efficiency.

The complications and challenges to optimize efficiency are non-trivial during nominal operations, and they are amplified considerably when constraints affect the system. During these off-nominal operations, which are often the result of compounding constraints such as convective weather and volume, strategies and decisions must be made to minimize NAS inefficiencies. Given all these complexities, it is a significant challenge to objectively identify and understand the root constraints and impacts in the system and whether the system performed well or poorly in consistently limiting constraint impacts and optimizing operational efficiency.

FY22 ACCOMPLISHMENTS: CAASD defined, developed, and tested a process and preliminary service for identifying, vetting, and prioritizing NAS efficiency challenges, adopting a data-informed, systematic approach supported by the FAA. Through this process, CAASD and our sponsors identified three areas to study that involve improving efficiency through more precise measuring of the problem and added operational context. In the areas of Airspace Flow Program application, re-route implementation, and high-surface delay, CAASD developed advanced analysis techniques to connect objective measures of constraints to responses from traffic management. CAASD also developed a high-level functional description for communicating NAS efficiency challenges, available findings, and current collaborative practices to decision makers.

FY23 PLANS: CAASD plans to exercise and demonstrate the NAS Efficiency Identification and Prioritization process by working with the Office of Advisory Circulars (AJR-1) traffic management and Collaborative Decision Making (CDM) sub-groups. CAASD will complete the historical Airspace Flow Program (AFP) analysis, advancing our en route congestion metrics and adapting modeling and simulation capabilities to explore the use of predictive analytics for AFP impact evaluations. To assist with communicating best practices, CAASD will work with the Office of System Operations (AJR) to mature and test a cognitive assistant concept to provide more intuitive access to best practices.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to identify and prioritize analysis to address FAA-identified challenges through the systematic and data-informed approach. CAASD will continue to mature and demonstrate the process of addressing those issues at the identified root causes and develop the concept and capabilities to assist traffic management decision makers in accessing best practices to improve efficiency.

More Agile Structure of Services and Service Levels

Over the years, the airline industry has evolved its operations and route networks, shifting traffic based on market demand. As the use of the NAS extends to a broader set of users, the FAA needs to reconsider what is the proper type and level of service, including how best to deliver that service. This applies to both services that support traditional manned aviation as well as services that integrate unmanned systems, advanced air mobility, and space operations.

To address this need, the FAA has started an initiative in FY22 to establish a framework for More Agile Structure of Services and Service Levels (MASS) across the NAS as part of the Operational Excellence pillar of the Flight Plan 21 strategic framework. MASS is a multi-phase, multi-year effort with the objective to develop a comprehensive set of up-to-date requirements informed by current operational data and future forecast data, determine the infrastructure and operational needs of a given facility or airspace, and use a repeatable and explanatory process to periodically revalidate needs.

FY22 ACCOMPLISHMENTS: CAASD, in partnership with the FAA, documented the landscape of existing NAS services and related metrics/criteria by analyzing seven ongoing agency efforts (programs and initiatives) reflecting the diversity of safety needs, service demand, and operational maturity prevalent in the NAS. The services referenced in the seven agency programs and initiatives were then mapped to the NAS Enterprise Architecture (NAS EA) Services to define the landscape of the NAS services being considered.

With the landscape of existing services defined and understanding of the indicators of service demand

shifts, the key concepts of the MASS framework were developed. The MASS framework lays out an agile provisioning process which monitors shifts in demand signal and reflects those in potential need for upgrade or downgrade of services at the service delivery source. The framework is designed to evolve with the NAS, such as emerging operations (e.g., space launch and reentry operations, UAS operations, and expected future operations such as Advanced Air Mobility [AAM] operations).

FY23 PLANS: CAASD will pursue the following activities in FY23:

- Apply the preliminary service level definitions and criteria to develop and analyze several use case example(s), identified through a strategic stakeholder engagement plan.
- Formalize partnerships with key stakeholder offices and related efforts to assure alignment, obtain feedback/buy-in, and to collaboratively apply the future framework relevant use case examples.
- Demonstrate an automated and data-driven process to drive decision making and collaborate with stakeholders on at least one of the service threads to highlight the utility of the new framework.
- Conduct analysis of staffing, technologies, and tools to support service levels of facilities and airspace.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD plans to pursue the following activities for FY24-26:

- Develop a strategic communication plan for outreach to engage airports, military, union, and industry stakeholders and conduct consultations with them.
- Establish a preliminary timetable for potential service level transitions based on data-driven analyses.
- Finalize an implementation plan with budgets to transition the proposed service level changes.
- Start execution of the implementation plan to transition proposed service level changes across the NAS (FY26).

Universal Access Transceiver Minimum Operational Performance Standards Version 3

The Universal Access Transceiver (UAT), which CAASD invented in the mid-1990s, is one of two worldwide standards for ADS-B technology used to exchange surveillance data.

FY22 ACCOMPLISHMENTS: Working with CAASD, RTCA completed work on version 3 of its Minimum Operational Performance Standards (MOPS) for the UAT. CAASD has been a significant technical leader in the development of UAT performance standards and innovations, using the technology for numerous applications from small unmanned aircraft to commercial space. This latest version of the standard enhances the data link's capability to transport aircraft-derived atmospheric and meteorological data (e.g., as input to potentially improve wind forecasting) and enable high-velocity and altitude ADS-B reporting supporting new entrant operations.

FY23 PLANS: CAASD will help the FAA to codify the UAT MOPS in a revised Technical Standard Order that will govern new avionics development.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will help the FAA to update the ADS-B airspace rule to align the law with the new technology aircraft operators need to use when operating in airspace requiring ADS-B Out.

Initial Trajectory Based Operations (TBO) Implementation

The FAA is evolving the NAS toward TBO to make flight operations more efficient and predictable, while maintaining operational flexibility. The FAA has defined a multi-phase evolution for TBO. The current phase, referred to as Initial TBO (iTBO), is focused on improved integration of arrival and departure management, accomplished primarily through integrated use of existing and planned automation.

A key component of iTBO is Time-Based Management (TBM), an ATM technique for scheduling aircraft through airborne and surface constraint points in the NAS. The FAA is evolving several decision support systems and related capabilities that enable TBM concepts for improved arrival and departure management.

iTBO implementation is already underway, and it will lay the foundation for additional investments needed to address the next phases of TBO (Full and Dynamic), which are the target over the next several years. CAASD is engaging across the FAA to methodically address a diverse set of iTBO implementation risk areas via data analysis, modeling, simulation, prototyping, and application of innovation. CAASD is also providing systems engineering for the refinement of new systems and capabilities, along with change management to help the FAA ready the workforce and operators for the desired operational changes.

FY22 ACCOMPLISHMENTS: CAASD was a crucial partner to the FAA in iTBO implementation. Using MITRE's IDEA Lab, CAASD conducted an interoperability simulation that allowed operational teams to understand the interactions among the TBFM system and the Terminal Flight Data Manager (TFDM) system in an operational context, with the simulation of arrival and departure operations at Los Angeles International Airport (LAX). At the time, TFDM was a still forthcoming system, so this event represented the first time these teams could see the suite of systems working together in an operational context that was valuable for risk reduction and implementation planning. CAASD also identified subsumption alternatives for legacy TFM capabilities in the field today that will be modernized with iTBO implementation.

CAASD also developed and delivered a suite of ATC workforce training materials for TBO and a training model to deliver improvements for ATC and Traffic Management personnel. CAASD worked in close collaboration with FAA Air Traffic Services, FAA System Operations, and the National Air Traffic Controllers Association (NATCA) to develop the workforce training material content and improved training design attributes.

Training delivery improvements were accomplished via use of MITRE's Networked Experimentation, Research, and Virtualization Environment (NERVE) and IDEA Laboratory. The FAA and CAASD successfully demonstrated an alternative training method in the context of TBFM system controller supplemental training, which was used for initial training at the Oakland Air Route Traffic Control Center (ARTCC) facility.

Additionally, CAASD worked closely with the FAA to complete TFDM system software testing and prepare site stakeholders for its implementation. CAASD provided systems engineering and operational expertise as part of the TFDM software system design, test, and

CAASD is providing change management to help the FAA ready the workforce and operators for the desired operational changes.

evaluation process and worked to ensure TFDM was appropriately integrated with other NAS systems and capabilities. In collaboration with the FAA, CAASD also engaged with airline, airport operators, ramp operations, general aviation entities, and other non-FAA stakeholders at targeted TFDM sites to prepare them and set expectations for TFDM implementation to enable Surface Collaborative Decision Making (S-CDM). The successful deployment of the initial TFDM operational system to the field was accomplished at the Cleveland Hopkins International Airport (CLE) tower in October 2022.

CAASD applied innovation to identify alternative architectures for trajectory management solutions to accelerate their availability to the field. Using a novel design and development approach that employed principles of the FAA's Automation Evolution Strategy, CAASD developed a proof-of-concept prototype for an en route controller path stretch capability as a feasibility exemplar for agile development concepts (e.g., web-based applications) to support the operation, gain early acceptance, improve cost-effectiveness, and validate required functionality.

Finally, in partnership with the FAA and NATCA, CAASD created and led a series of informational TBO Industry Days to help aircraft operators and other stakeholders better understand the FAA's implementation strategy for iTBO, its objectives, and recent achievements. CAASD also developed the FAA's TBO Analytical Tool, featured at an FAA TBO Industry Day, which is designed to support post-implementation operational analysis to determine and communicate progress toward TBO success criteria.

FY23 PLANS: CAASD will continue to provide multi-faceted analysis and subject matter expertise to identify and mitigate risks related to iTBO implementation and will perform analyses related to post-implementation impacts of new implementation and use of iTBO capabilities. CAASD will work with the FAA to support the successful operational transition of iTBO across the NAS, including expanding use of the TBFM system and the supporting TFDM deployment

waterfall. CAASD will help the FAA navigate the impact of recent budget changes and reestablish implementation priorities. CAASD will employ change management science to continue readying the workforce, conduct site collaboration activities to establish S-CDM processes, procedures, and policies in preparation for the deployment of TFDM's surface metering, and provide consistent and timely communication to all stakeholders via targeted engagements. Additionally, CAASD will further mature development of the TBO Analytical Tool, a post-operations assessment platform to integrate additional TBO success criteria and metrics, for the purpose of providing a clear understanding of the operational changes and their benefits. CAASD will also continue working with the FAA to expand use of the Integrated Performance-Based Navigation (PBN) and TBM Design capability and design guidance to reduce the time and resources needed to develop TBFM adaptation and validate the integration with PBN procedure designs at key sites in the NAS.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to be the FAA's partner for the transition to iTBO across the NAS, providing subject matter expertise on iTBO technologies and their operational impact. CAASD will continue to address specific operating area implementation considerations, mitigate remaining risks, and identify opportunities for additional improvements and efficiencies based on iTBO implementation lessons learned.

OUTCOME

03

AIRSPACE AND PERFORMANCE-BASED NAVIGATION

FAA Outcome Manager: Mr. Chris Hope and Mr. Shawn Kozica

CAASD Outcome Leader: John Brandt

Outcome Statement: A modern and effectively managed performance-based NAS that:

- Leverages the precision, reliability, predictably, and efficiencies of PBN through the application and integration of Area Navigation (RNAV) and Required Navigation Performance (RNP) capabilities.
- Effectively integrates the NextGen vision and capabilities, such as TBO.
- Increases operator safety, access, resilience, efficiency, and capacity.
- Improves controller productivity and situational awareness.
- Promotes international harmonization and seamless global operations.
- Transforms the NAS by leveraging the benefits of navigation performance with surveillance, automation, and communications.
- Implements environmentally conscious trajectories in an agile and efficient manner.
- Increases flexibility and predictability to benefit air traffic controllers and operators.
- Reduces delays and inefficient routings appropriately depending on the needs of the airspace and its users, based on measurable success criteria monitored in a rigorous, timely, and data-informed manner.
- Balances the access needs of a diverse set of aviation system users.
- Maintains the highest levels of system safety and security.

Highlighted Accomplishments

Airspace Modernization Roadmap

The FAA continually updates and modernizes its airspace services and infrastructure to enhance safety and efficiency while safely integrating new users and technologies into the NAS. With the Metroplex program sunsetting in 2022 and new types of operations entering service, there is a need to develop holistic and integrated plans for airspace modernization over the next several years, as well as to update and align the longer-term airspace modernization strategy with the evolving and emerging needs of the future info-centric NAS. To that end, the FAA is partnering with CAASD to develop an Airspace Modernization Roadmap.

FY22 ACCOMPLISHMENTS: CAASD partnered with the FAA on a range of Roadmap-related activities in FY22. CAASD developed the initial drafts of the Airspace Modernization Roadmap. CAASD also developed the initial Airspace Modernization Playbook, which builds upon experience and lessons learned from Metroplex and other airspace and procedure modernization projects to describe how future airspace modernization projects will be conducted under the new Service Center execution model that the FAA is adopting. CAASD also developed a process for prioritizing airspace modernization activities at the busiest airports across the NAS, and conducted the initial quantitative safety and efficiency analysis of operational needs that fed into the site selection process. That site selection process also considered qualitative factors such as the feasibility of addressing the operational needs with airspace modernization, site readiness, scheduling considerations, and other factors. At the end of FY22, CAASD began working on scoping and planning for the site-specific projects the FAA prioritized.

FY23 PLANS: CAASD will update the FY22 quantitative analysis to cover initiatives and objectives beyond individual site-specific airspace projects, including PBN Route Structure and en route focused projects, as well as smaller airspace projects across the NAS. This will include expanding the safety and efficiency metrics considered to better account for factors such as delay and traffic growth. CAASD will also partner with the FAA to scope and initiate the first site-specific airspace modernization activities under the new operating paradigm, providing strategic planning, systems engineering, and analysis to ensure the successful execution of these critical projects. As these projects proceed, CAASD will also document lessons learned and best practices to continue to refine the airspace modernization processes outlined in the Airspace Modernization Playbook.

FY24 – 26 THREE-YEAR LOOK-AHEAD: As these initial projects kick off and follow-on projects are initiated, CAASD will continue to partner with FAA's Mission Support Services Airspace Modernization Group and the Service Center execution teams throughout the project lifecycle, from needs identification and prioritization to project scoping, airspace and Instrument Flight Procedure (IFP) design, systems integration planning, and project implementation. In this role, CAASD—through data-driven analysis and strategic advising—will empower the FAA to act strategically to realize the full potential of its airspace modernization efforts. CAASD will also continue to work with the FAA to ensure the Airspace Modernization Roadmap evolves as needed to help the FAA progress toward an info-centric NAS.

Metroplex Airspace and Procedure Modernization

The Metroplex program was the FAA's NextGen initiative to implement PBN procedures and redesign the complex airspace surrounding major metropolitan areas. The overall goal was to improve operational efficiencies around the nation's busiest airports by: (1) reducing reliance on aging, ground-based navigation infrastructure; and (2) leveraging modernized capabilities (e.g., Data Communications [DataComm], iTBO, ADS-B, etc.) that are no longer dependent upon legacy communication, surveillance, or automation systems.

By transitioning the NAS to PBN operations and enabling optimal integration of airspace, procedures, and automation, the FAA is providing more efficient and more predictable flight paths, reducing pilot/controller communications, and reducing maintenance and infrastructure costs. CAASD has fulfilled many roles with the FAA since the program's inception in 2010. These include characterizing operational issues, providing subject matter expertise on proposed design concepts, conducting both fast-time and real-time ATC simulations, and performing aviation data analyses (including detailed post-implementation analyses) to assess implementation impacts.

FY22 ACCOMPLISHMENTS: CAASD conducted the post-implementation analysis of the 11^{th} and final Metroplex site, South/Central Florida, and worked with the FAA to close out that project and the overall program.

The South/Central Florida Metroplex post-implementation analysis CAASD conducted indicated a reduction in fuel consumption of 4.1 million gallons per year, which translates to an estimated net savings of $11.8 million per year and a reduction of 35.1 thousand metric tons of carbon dioxide (CO2) emissions annually.

Following the completion of the Florida project, CAASD worked with the FAA to ensure the 12-year program left an enduring legacy of best practices and lessons learned that can be used to accelerate and streamline future airspace modernization activities. CAASD documented programmatic costs, benefits, best practices, and lessons learned, and compiled an archive of authoritative information on the program and the 11 projects that were completed between September 1, 2010, and June 30, 2022. The result of comprehensive airspace and procedure redesigns was the publication of 867 new or modified procedures, estimated to save over 18 million gallons of fuel annually and reduce the output of carbon dioxide by over 150,000 metric tons per year. In addition, other non-quantifiable benefits achieved included reduced airspace complexity and reduced workload for both pilots and controllers. Adjusted for inflation and discounted to a base year of 2014, the total cost of the Metroplex program was $191 million over the length of the program. In return, the total discounted benefits from fuel savings through 2030 are estimated to be $362 million. This results in a positive Net Present Value for the program of $171 million, and a benefit-to-cost ratio of nearly 2-to-1.

FY23 PLANS and FY24 – 26 THREE-YEAR LOOK-AHEAD: As the FAA kicks off new airspace modernization projects associated with the Airspace Modernization Roadmap in FY23, the many lessons learned and best practices compiled over the lifetime of the Metroplex program are being used to scope, plan, and execute these efforts. CAASD's lessons learned and best practices from Metroplex design and implementation, knowledge of airspace and procedure integration considerations, understanding of TFM and NAS systems, and expertise in new entrants and NextGen capabilities will enable the FAA to continue to implement beneficial airspace infrastructure improvements across the NAS over the coming years.

Northeast Corridor (NEC) Airspace and Procedures Analysis & Strategic Planning

The airspace in the NEC between Washington, D.C. and Boston remains the most complex and congested in the country. As a result, the FAA and the NextGen Advisory Committee prioritized implementation of new capabilities and new airspace and procedure designs to improve operations and increase efficiency within the NEC. The FAA has committed to meeting NEC airspace and procedure assessment and implementation milestones. Beyond those milestones, the FAA will continue to introduce new capabilities and implement airspace and procedures enhancements to achieve iTBO objectives and address existing and emerging operational shortfalls in the NEC.

CAASD has partnered with the FAA in its efforts to modernize this complex airspace. CAASD's work involves conducting strategic planning and systems engineering activities to assess the feasibility, risks, and benefits of proposed changes as well as developing conceptual designs and evaluating their impacts and benefits through modeling and simulation.

FY22 ACCOMPLISHMENTS: The FAA and CAASD continued work to advance the near-term design and implementation of airspace and procedure solutions in New York and the NEC, while also conducting analyses to identify operational shortfalls through the analysis of safety and efficiency metrics at the busiest NEC airports. CAASD continued to support the implementation of the Eastern Seaboard High Altitude PBN Routes, with full implementation anticipated in FY23. CAASD also continued to conduct analyses and strategic planning activities to help the FAA make data-driven decisions regarding the waterfall of route modification activities needed to support the Very High Frequency Omni-Direction Range Minimum Operational Network (VOR MON) in the NEC.

Beyond these near-term activities, CAASD partnered with the FAA to develop a longer-term strategy for more holistic modernization of the airspace surrounding the New York metropolitan area. CAASD validated, refined, and updated the conceptual designs developed in FY21 and then created a series of implementation options and timelines based on refined estimates of costs and benefits, updated timelines for advanced concepts such as Multiple Airport Route Separation (MARS), and refined environmental screening. CAASD estimated that implementing the conceptual designs through a holistic and integrated airspace modernization project could provide: an annualized benefit of up to $68.8 million in airline direct operating cost benefits; reduced ATC complexity; reduced noise exposure for communities; a foundational structure for TBO; and improved operational predictability. While CAASD also continued to conduct preparatory analysis for advanced concepts such as MARS to understand potential operational requirements, the analysis showed that 70% of the potential benefits of

New York airspace modernization could be achieved with existing separation standards and rules.

FY23 PLANS: CAASD will work with the FAA to complete the implementation of the Eastern Seaboard High Altitude PBN Routes, while continuing to conduct strategic planning and analysis activities to help the FAA make data-driven decisions regarding the NEC VOR MON waterfall.

In addition, CAASD will continue to support the FAA in strategic planning for future New York airspace modernization activities, exploring potential FAA benefits, defining opportunities and strategies for Class B modifications, and continuing to refine alternative strategies for design and implementation. The goal of this work will be to have a clearly articulated plan and FAA buy-in on a path forward to address operational shortfalls in this highly congested and complex airspace.

FY24 – 26 THREE-YEAR LOOK-AHEAD: Going forward, it is envisioned that CAASD will continue to partner with the FAA to: meet NEC commitments; develop environmental, community engagement, and design and implementation strategies; implement beneficial airspace and procedure solutions; and evolve NEC operations to iTBO and beyond toward an info-centric NAS. Given the density and complexity of the airspace, the proximity of the airports, and the multiple ATC facilities involved, CAASD will leverage its knowledge of emerging NextGen capabilities and the work on the mid-term conceptual design to support the FAA in planning and executing a future airspace modernization project. The project will consider lessons learned from airspace, procedure, and automation implementation activities in major metropolitan areas across the NAS. The project will also help the FAA operationalize and institutionalize the use of benefits-enabling technologies that are foundational for transitioning New York to TBO.

Instrument Flight Procedures, Operations, and Airspace Analysis (IOAA)

CAASD developed the IOAA Tool to provide integrated metrics and analysis capabilities directly to FAA analysts. The tool supports data-driven assessment of IFP needs, IFP post-implementation analyses, identification of operational issues related to the use of IFPs, progress toward PBN NAS Navigation Strategy goals, and separation standards safety studies.

FY22 ACCOMPLISHMENTS: CAASD deployed a new authentication system in early 2022 that enabled FAA login to the IOAA Tool via My Access and ensured uninterrupted user access. CAASD engaged with FAA Service Centers and other IOAA stakeholders to demonstrate the IOAA Tool and identify additional work areas that IOAA can support, including airspace modernization efforts, procedure implementation workflows, and community engagement needs.

CAASD improved the IOAA capability by maturing data processing automation and system monitoring capabilities, including improving level-off and procedure usage data with new analytics from MITRE's Transportation Data Platform (TDP). CAASD also enabled new data-driven insights by developing and deploying new IOAA capabilities, including an airspace usage analysis module, improved track visualization including range and altitude filtering, and an IFP Retirement module that provides automated criteria for IFP inventory maintenance decisions. CAASD also developed and validated additional algorithms within TDP to identify re-routes, shortcuts, and vectors.

CAASD also enhanced FAA access to IOAA data within FAA systems, developed a cloud-based IOAA prototype, and delivered an IOAA technology transition roadmap based on the lessons learned in prototype development.

FY23 PLANS: CAASD will continue pursuing ad hoc analyses, increasing automation to streamline IOAA data updates, and evolving IOAA analytic capabilities as prioritized by FAA Mission Support, Flight Standards, and other IOAA stakeholders. CAASD will develop a new re-route, shortcut, and vector analysis module; a Class B airspace excursion analysis module; a track density visualization capability; and additional surveillance data-based flight track visualization capabilities. CAASD will also explore cloud-based database solutions and integrate some IOAA capabilities into CAASD's Collaborative Research Environment (CRE) as part of execution of the technology transition roadmap.

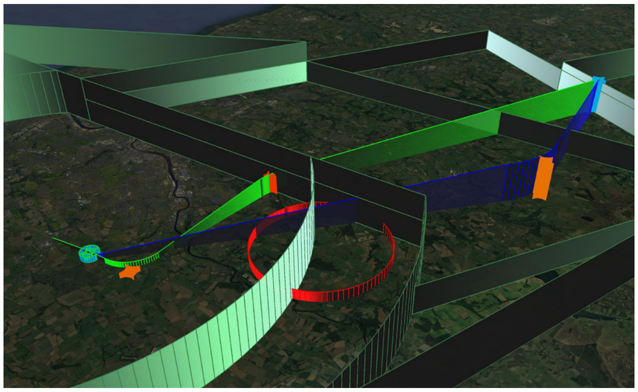
FY24 – 26 THREE-YEAR LOOK-AHEAD: The integrated IOAA capabilities will continue to be integrated into a variety of critical FAA work programs, including execution of the Airspace Modernization Roadmap activities. CAASD will continue partnering with FAA's Mission Support and Service Center execution teams to directly leverage IOAA for project scoping, and airspace and IFP design and implementation activities, streamlining project decisions using automation-enabled, data-driven insights. The FAA will also leverage the advanced algorithms that drive IOAA analytics to streamline data preparation and modeling efforts for separation standard safety studies, a critical step in enabling standards that increase airport capacity and flight efficiency in the NAS. CAASD will also coordinate with FAA data infrastructure teams to increase FAA access to underlying IOAA data and enable co-development of analytic capabilities to meet FAA needs.

IFP Production Process Streamlining

IFPs are part of the navigational backbone of the NAS, and they are critical to flight safety, as well as operational efficiency. Today there are approximately 23,000 IFPs in the NAS, with increasing demand to incorporate more efficient navigational services and innovative types of operations. However, this large inventory and constrained resource environment have challenged the FAA's ability to maintain the existing inventory while furthering the FAA's and industry's navigational objectives.

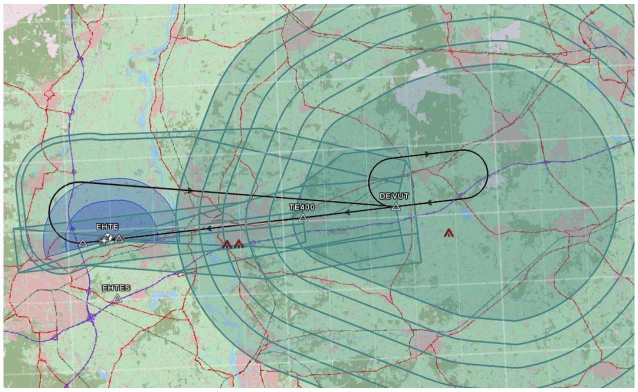
CAASD is partnering with the FAA to enable the complex IFP production process to become more efficient, data-driven, and adaptable based on the changing needs of the NAS. Therefore, improvements to the IFP production process need to consider not only automation capabilities, but also how to integrate them into the existing IFP production workflow processes.

FY22 ACCOMPLISHMENTS: CAASD approached the challenge of increasing the efficiency of the IFP production process by focusing on key stages of the process: IFP criteria development, IFP design automation,



IFP production tracking, and IFP retirement. CAASD worked with Flight Standards to adapt agile methodologies to their development of highly technical IFP design criteria. In addition, CAASD coordinated with Flight Standards and Mission Support Services to introduce new methods of assessing the impact of proposed changes to IFP design criteria on the IFP inventory and automation systems. This will help avoid high-cost/low-benefit changes and unintended consequences. CAASD also worked with the regional Flight Procedure Teams to continue development and operational testing of an Automated Procedure Design capability intended to reduce the effort needed to design optimal IFPs. CAASD collaborated with Mission Support Services and the Flight Procedure Teams on the continued development and operational testing of contextualized, data-driven, IFP retirement recommendations and integration of them with enterprise workflow tracking tools. This automated capability will allow more rapid identification and coordination of operationally redundant IFPs. Finally, CAASD mapped the IFP production process, conducted data analysis, and developed requirements for a future system to enable more data-driven IFP production prioritization and tracking.

FY23 PLANS: The FY22 efforts form the foundation for continued progress in FY23 toward a streamlined IFP production process in which IFPs can move more quickly from design into operational use and with less effort than is needed today. Additionally, the inventory of IFPs will more accurately reflect the operational needs of NAS users, enable unnecessary IFPs to more easily be removed from the inventory, and enable operational benefits for new navigational services to be identified for addition. Considering the IFP production process as a complex, cross-organizational system, CAASD efforts will focus on improvements to data management, automation systems, and workflow process improvements. It is expected that CAASD-developed contextualized, data-driven IFP retirement recommendations will be deployed for operational use, and retirement recommendations expanded to additional procedure types. CAASD will also continue to collaborate on ways to improve the FAA's understanding of the impact of proposed changes to IFP design criteria. CAASD will begin working with Flight Standards and Mission Support Services on ways to enable more efficient handling of special IFPs and waivers to IFP criteria and improve the integration of this process with the overall IFP production process. CAASD will also develop automation capabilities and process recommendations to provide enterprise-level optimization for IFP production and enable more accurate balancing of conflicting demands. Finally, CAASD will focus more broadly on enabling the early stages of the IFP production process that are more tailored to their operational environment to reduce production demand due to avoidable rework and revision.



FY24 – 26 THREE-YEAR LOOK-AHEAD: The IFP production process is a complex system that spans numerous FAA organizations; therefore, making substantive efficiency improvements will require a broad engagement that considers changes to policy, automation, data management, organizational workflow processes, and an accurate assessment of industry needs. This will include continued improvements to the feedback provided to IFP designers, data-driven insights into IFP prioritization and scheduling, deployment of data-driven recommendations for IFP retirement, and improvements to workflows and policy to further improve production efficiency.

OUTCOME 04

SAFETY AND TRAINING

FAA Outcome Manager: Mr. Scott LeMay and Mr. Joe Bello

CAASD Outcome Leader: Stephen Szurgyi

Outcome Statement: An improved NAS system safety environment that:

- Implements safety standards for operations, airport and airspace design features, and infrastructure.
- Institutes safety assurance processes as an integral part of normal operations.
- Utilizes metrics to proactively detect issues prior to incidents or accidents.
- Leverages the collaboration of operational experts across the agency and research into technologies and capabilities to improve safety.
- Improves the delivery, quality, flexibility, and standardization of controller training, reduces the training time and costs to certify a controller, and facilitates a more effective operational transition of NextGen solutions.

Highlighted Accomplishments

Aviation Safety Information Analysis and Sharing (ASIAS)

The ASIAS program is a collaborative government and industry initiative to share and analyze large volumes of data to proactively discover system safety concerns before accidents or incidents occur, leading to timely mitigation and prevention. The ASIAS program collects and analyzes large volumes of airline proprietary and public data to support hazard mitigation efforts in the NAS and enhance safety across the aviation community.

As the ASIAS Trusted Third Party (TTP), MITRE serves as the:

- **Trusted data steward**, providing the secure data environment and related capabilities to protect and manage partner data and results.
- **Analytic lead**, working with government and industry to identify emerging hazards and to conduct data-driven analysis to evaluate their impact to flight safety.
- **Research innovator**, identifying, prototyping, implementing, and leveraging novel analytical capabilities to unlock safety insights from the large amount of ASIAS data.

FY22 ACCOMPLISHMENTS: The Commercial Aviation Safety Team (CAST) recently concluded a study of hazards associated with the approach/landing and go-around phases of flight, focusing on why go-arounds are infrequent (even in cases warranting one based on established guidance) and why some go-arounds result in undesired aircraft states. CAASD conducted detailed analysis of ASIAS data and provided technical briefings of the results to the CAST study team throughout the span of the study. At the conclusion of the study, CAST drafted and adopted Safety Enhancement (SE) 236 (Improving Pilot Go-Around Decision-Making and Outcomes) and 237 (Improving Pilot-Controller Communications Within the Constructs of Go-Arounds) to mitigate latent risks associated with the approach/landing and go-around phases of flight. CAST will use ASIAS metrics to identify unstable approach events to measure the efficacy of these two SEs as they are implemented over time.

Denver International Airport (KDEN) has one of the highest rates of Traffic Alert and Collision Avoidance System (TCAS) Resolution Advisories (RA) in the NAS, largely due to its unique combination of high elevation and approaches to closely spaced parallel runways

Photo is from the ASIAS 15-year anniversary All Hands meeting. Left to right, Scott LeMay (FAA, AVP-200), Ed Walsh (MITRE, ASIAS Program Manager), and Walt Hogan (FAA, AVP-220, ASIAS Program Manager)

16L and 16R. CAASD provided technical briefings on the results of ASIAS analyses to the KDEN TCAS Safety Risk Management (SRM) Panel, informing the panel's decision making and leading to the publication of Safety Alert for Operators (SAFO) 22003, which "serves to alert all operators and pilots of the high number of TCAS alerts when flying approaches to DEN RWY16L/16R and includes supplemental guidance and recommendations for evaluating TCAS II procedures."

MITRE has had the privilege of operating as the ASIAS TTP for 15 years. In that time, MITRE has played a key role in the growth of ASIAS, which now has participation from over 240 stakeholders, including commercial, general aviation, and rotorcraft operators, industry organizations, government agencies, and flight training schools. With MITRE as the TTP, ASIAS has conducted more than 150 studies resulting in action, including 24 CAST SEs and numerous additional localized mitigations to reduce aviation risk.

"ASIAS is one of the crown jewels of the aviation safety system in the United States. It is unique in the world."

—Former FAA Administrator Stephen M. Dickson, comments to the U.S. House of Representatives Committee on Transportation & Infrastructure, December 2019

"MITRE has been a key element in the success of ASIAS across fifteen years, establishing foundational data governance and technical capabilities."

—Walt Hogan, FAA AVP-200, ASIAS Program Manager, September 2022

FY23 PLANS: MITRE will continue stewardship and fusion of the ASIAS data, enabling studies and safety metrics on an aviation safety database unparalleled in the world. MITRE will also provide data and analysis leadership to study teams focusing on hazards associated with general aviation operations at non-towered airports and rotorcraft loss of control inflight. MITRE will further advance the science of safety by developing novel analytical capabilities that implement the state of the art in AI/ML, including multiple-channel predictive analytics for sensor and telemetry data and knowledge graphs for safety reporting data.

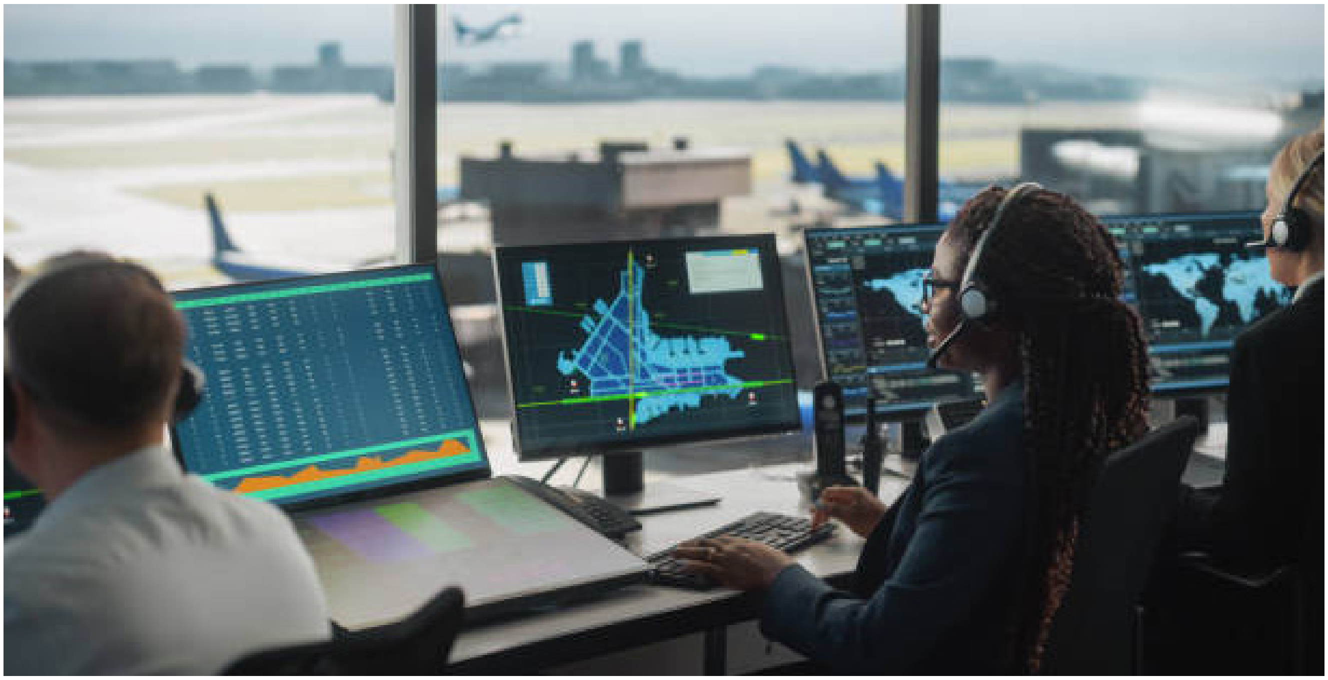
FY24 – 26 THREE-YEAR LOOK-AHEAD: In the next three years, MITRE will develop and enable an end-to-end strategy in coordination with the FAA and ASIAS stakeholders for a seamless, successful transition of ASIAS operations to a new commercial vendor, dubbed ASIAS 3.0. ASIAS 3.0 is in the early planning stages and will include a new underlying infrastructure and associated tools and processes to collect, transform, store, organize, integrate, analyze, and share aviation safety data and information for the ASIAS program. In parallel to transition-related efforts, MITRE will continue to ensure uninterrupted operations of the legacy ASIAS system, enabling aviation safety studies and metrics to continue.

AVS Workforce Evolution

In FY22, CAASD collaborated with the FAA Office of Quality, Integration and Executive Services (AQS) within the Office of Aviation Safety (AVS) to analyze industry activity, including manufacturers, maintenance facilities, general aviation, and commercial operators to identify industry drivers of AVS's volume of work and workforce demand. CAASD also investigated available data and developed analytic approaches for workforce planning.

The background for this request is related to the January 2020 recommendations of the Special Committee to Review the FAA Aircraft Certification Process, which asked AVS to implement a comprehensive process for determining staffing levels that includes important data on workload drivers to ensure that personnel with applicable skills occupy safety-critical positions. AQS is responsible for publishing the AVS Workforce Plan, providing staffing projections for all AVS offices and the President's Budget, and decided to collaborate with CAASD on its response to this important recommendation.

FY22 ACCOMPLISHMENTS: CAASD enabled AQS and the FAA's Office of Labor Analysis (ALA) to update the methodology to produce more realistic and better-informed workforce plans through a cross-domain partnership between CAASD, MITRE's Transportation Innovation Center, and the Enterprise Strategy and Transformation Innovation Center. The team produced a workload analysis model to define current and future workforce requirements more accurately by accounting for industry drivers of workforce demand. This model is an important component of workforce planning that involves a systematic process to measure and detail AVS's current and future workload and allocation of Full-Time Equivalent (FTE) effort. The project team also leveraged available industry data and inputs from subject matter experts to produce an industry analysis of drivers and operational indicators that the FAA can use to improve its workforce planning approach. The industry analysis focused on the impact of new technologies, changes in industry performance, and economic fundamentals as key drivers of change in AVS's work and workforce demand. The results of CAASD's work will help inform the AVS Management Team, the Special Committee of the FAA Certification Process, and the U.S. Congress. The capabilities developed through this project improved the FAA's ability to conduct strategic and predictive workforce planning to make more objective, defensible decisions to manage staffing that focuses on risk.



FY23 PLANS: In FY23, CAASD will continue to collaborate with AQS and ALA to incorporate industry drivers into the AVS staffing model. This work will include validation of industry drivers through the inputs of AVS subject matter experts, implementation of the industry drivers into workforce planning, and the generation of more informed FTE estimates. The project will also include leveraging data-driven economic analysis methods to forecast the impact of industry trends on current and future drivers of AVS's workforce demand.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue collaborating with the FAA and partners to demonstrate the impact of workforce evolution capabilities. The products and lessons learned from these activities will have potential applications across other AVS Services and Offices and other FAA lines of business, including the Air Traffic Organization (ATO).

The capabilities developed through this project improved the FAA's ability to conduct strategic and predictive workforce planning.

OUTCOME 05

COMMUNICATIONS, NAVIGATION, SURVEILLANCE, AND CYBERSECURITY INFRASTRUCTURE

FAA Outcome Manager: Mr. Malcolm Andrews

CAASD Outcome Leader: Frank Buck

Outcome Statement: Enable the FAA to take a global leadership role in aviation Communications, Navigation, Surveillance (CNS) and information system security. Provide sustainable, cost-effective, and secure information technology and CNS infrastructure through modernizing the NAS in such a way that it:

- Establishes the CNS foundation for FAA's mid-term and far-term evolution strategies and improves operational safety, efficiency, access, and capacity while enabling environmentally friendly and efficient operations.
- Leverages commercial and emerging technologies to provide robust aviation solutions and cost-effective CNS and cybersecurity capabilities and services.
- Provides the FAA and the aviation community with flexible, resilient, reliable communications services.
- Enables greater controller productivity and improves the overall provision of the Air Traffic Service.
- Focuses cybersecurity efforts on FAA mission assurance by promoting situational awareness, agility, resilience, recoverability, and reconstitution in the eventuality of successful cybersecurity attacks.
- Enables the transformation of the NAS by leveraging the benefits of navigation performance with emerging surveillance, automation, and communications systems.
- Enables the FAA to deliver value-added aeronautical, weather, and flight information services to the NAS and the aviation community.
- Enables the FAA to remain the world leader in aviation and advance CNS international harmonization and seamless global airspace interoperability.

Highlighted Accomplishments

Zero Trust

The FAA is aligning with federal government mandates to improve its cybersecurity posture and, to that end, is actively engaged with strategy and planning for the incremental migration to a Zero Trust Architecture (ZTA).

As digital transformation accelerates across private industry and government, new capabilities such as cloud, the proliferation of mobile devices, and a growing need for increased sharing of data across the aviation ecosystem increase the urgency and need to the move to a zero trust model. In addition to that, the legacy castle-moat cybersecurity architecture prevalent in industry and present at FAA is showing its weaknesses as adversaries successfully breach firewalls, gain access, and move laterally in protected networks. Zero trust enables organizations to move beyond traditional perimeter-based defenses by distributing perimeter functions closer to the resources. The transition to zero trust will require changing some of the ways the FAA thinks and acts with respect to cybersecurity, including efforts to secure its systems and digital information.

The implementation of the zero trust model will result in improved protection of FAA systems and digital information, thus strengthening mission assurance. The adoption of zero trust principles and capabilities will help improve the FAA cybersecurity ecosystem to identify, protect, detect, respond, and recover from potential cyber threat campaigns. To achieve success, the FAA journey toward zero trust requires coordination across a variety of enterprise stakeholders, and the implementation must be done incrementally to avoid disruptions to mission services.

FY22 ACCOMPLISHMENTS: CAASD worked with the FAA to develop a Zero Trust ConOps and a draft Zero Trust Implementation Plan. The ConOps document provided descriptions of representative zero trust use cases. Its purpose is to help users understand how new and existing cybersecurity capabilities will function across FAA operating environments within the new zero trust model. The ConOps focuses on a core set of zero trust use cases that are representative of common data flows within and across the FAA operating environments.

The ConOps document also includes transition considerations to a ZTA, with near-term emphasis and priorities on processes and capabilities to support the identified use cases. Critical transition considerations include the shift from program-centric security capabilities to programs and systems leveraging shared enterprise services and common security controls. This shift will ensure that FAA platforms and services are designed to support the enterprise standards, interfaces, and tools that are needed in a ZTA. This includes improved automation of processes for security assessment and authorization.

Transition to zero trust is expected to prioritize different initial capabilities and proceed at different rates across the FAA's operating environments. To help the FAA better understand the transition and implementation of zero trust capabilities, CAASD worked with the agency to develop an initial Zero Trust Implementation Plan.

It is important to recognize that the implementation of zero trust capabilities across the FAA will be a journey; it is not a quick transformation of the enterprise. The implementation of zero trust is a multi-year endeavor that will require continued coordination, collaboration, and approval of FAA stakeholders as new capabilities are deployed across the enterprise.

The draft Zero Trust Implementation Plan recommends addressing funding, resources, executive and management support, and overarching governance elements to advance and accelerate zero trust implementation as soon as practical. This plan also recommends an incremental and iterative implementation approach including planning; architecture, requirements, and engineering; technology evaluation; and capability implementation and integration.

Both the Zero Trust ConOps and the Implementation Plan have been adopted by the FAA, and they are laying the groundwork for the FAA's move to a zero-trust cybersecurity model.

FY23 PLANS: CAASD will work in collaboration with FAA's Zero Trust Team to conduct analysis and develop updates to the Zero Trust use cases. CAASD will mature the Zero Trust Implementation Plan across the FAA's operating environments to include incremental phasing of capabilities based on the Zero Trust ConOps and technical analysis. This will include moving from capabilities to more specific program requirements for zero trust.

To mature the FAA's ZTA, CAASD will assess existing cybersecurity capabilities and engage with current cyber capability owners to make recommendations on which capabilities to keep or replace, and to identify capability gaps. This will help the FAA develop a finer level of detail on early, mid-, and longer-term implementation decisions.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to work with the FAA on its journey to achieve a zero trust cybersecurity architecture. CAASD will help assess the implementation of zero trust cybersecurity capabilities as well as help the FAA chart its next steps amidst the changing landscape of emerging threats, developments in zero trust technologies, and the application of these technologies to FAA's operating environments.

GPS Resilience

A primary concept of NextGen was a transition to satellite-based services. However, the signal strength from satellites is by its nature very low. The Global Positioning System (GPS) signal can be denied and manipulated. This threat is increasing as the NAS dependency on GPS is increasing. Detection of interference is essential, but a clear understanding of impacts as well as operational mitigations and long-term alternatives is required for a comprehensive plan.

FY22 ACCOMPLISHMENTS: CAASD created a highly reliable spoofing detection solution on a portable electronic device (unmodified cellphone) that required less than $50 of additional hardware to operate. Hardware simulation of a realistic instrument approach spoofing scenario, along with car and flight tests validated the performance of the solution. CAASD also created a prototype of a situational awareness web-based tool for aviation stakeholders to see the health of GPS in near-real-time based on ADS-B data. In addition, CAASD created a ConOps for major airports to detect and respond to various types of GPS events. CAASD

continues to work through standards bodies to refine standards for robust, resilient GPS equipment for future aircraft.

FY23 PLANS: CAASD is working with the FAA to create a prototype tool for air traffic control to be able to monitor not only the status of GPS navigation, but also current navigation alternatives such as VOR and DME/DME (Distance Measuring Operation). This will give controllers an essential tool to understand both the extent of events as well as which mitigations will be more effective in both a strategic and tactical manner.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to work with the FAA and other government organizations to address the threat of GPS interference. This will include deployment of production capabilities of CAASD prototyped concepts and the development of future complementary position, navigation, and timing systems for the NAS.

CAASD created a prototype tool for aviation stakeholders to see the health of GPS in near real-time.

Infusion of Cybersecurity into the FAA Environment

The risks to the FAA from cyber-attack and cyber-compromise are substantial. As the FAA continues to evolve its computer and automation systems, those risks grow given the increasing complexity, increasing cyber-attack surfaces, and the incorporation of commercial off-the-shelf technologies into the FAA environment.

FY22 ACCOMPLISHMENTS: Over the past year, CAASD assessed FAA's cybersecurity infrastructure needs and infused proven cybersecurity technologies into FAA operational capabilities. As cybersecurity adversaries become more sophisticated and threats increase, there is a continuing need to assess FAA systems for vulnerabilities to emerging threats. CAASD has developed a suite of cybersecurity tools that help our government sponsors become better informed about how adversaries are attacking their systems and data. CAASD's objective with the FAA is to apply our tools and expertise to help the FAA across multiple lines of business and improve and enhance its capabilities.

To that end, CAASD worked with the FAA to assess and improve its cybersecurity posture by operationalizing the Adversarial Tactics, Techniques, and Common Knowledge (ATT&CK®) Framework into various FAA environments. ATT&CK is a MITRE open source, globally accessible knowledge base of adversary tactics and techniques based on real-world observations. ATT&CK includes knowledge bases for traditional enterprise IT risks as well as those specific to Operational Technology/Industrial Control Systems (OT/ICS) equipment. CAASD also evaluated opportunities to apply additional cybersecurity capabilities like CALDERA, an adversary emulation capability, into the set of cyber tools that the FAA uses for cyber defensive operations and penetration testing.

FY22 ACCOMPLISHMENTS: CAASD worked across multiple FAA organizations to enhance FAA cybersecurity capabilities by operationalizing MITRE ATT&CK into FAA operations. These enhancements will improve FAA's understanding of how adversaries might affect operations and safety at air traffic control facilities and other FAA support environments such as the Mission Support and R&D domains.

As part of the ATT&CK integration, CAASD defined use cases, developed ATT&CK Threat Cards, and made recommendations on the use of MITRE's ATT&CK Workbench and Navigator capabilities at the FAA Security Operations Center (SOC). CAASD also assessed and made recommendations to the SOC for use of CALDERA.

CAASD also worked with FAA teams to assess OT risks to their ATC facilities. CAASD leveraged its OT Cyber Resiliency Methodology to identify critical power system assets and perform Crown Jewel Analysis (CJA) to understand how these assists supported operations. Again, using MITRE ATT&CK, potential cybersecurity vulnerabilities were identified, and MITRE made a corresponding set of mitigation recommendations to address the identified shortfalls.

CAASD also worked closely with the FAA to incorporate the ATT&CK framework into the Penetration Testing Program for the Mission Support domain. By adapting a methodology defined by MITRE's Center for Threat-Informed Defense, ATT&CK is now integral in the penetration testing standard operating procedures for the Mission Support domain.

ATT&CK®

Lastly, CAASD made recommendations to enhance and standardize the sharing of cyber threat intelligence information within the FAA.

FY23 PLANS: CAASD is continuing to work with the FAA to infuse cybersecurity into the FAA environment. This includes working with the FAA to help further evolve FAA cyber threat intelligence capabilities and improve the efficiencies of the Penetration Testing Program to significantly increase the number of tests conducted per year while at the same time producing and communicating impactful results. CAASD will provide training on CALDERA as applicable for FAA's cyber exercises.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD plans to continue working with the FAA to infuse needed cybersecurity technologies into the FAA environment. This includes working in the areas of defensive cyber operations and cyber threat intelligence. CAASD will work with the FAA on further assessment of OT/ICS cyber resiliency with an intentional focus on cyber-physical systems installed throughout the NAS; integrating adversary emulation into penetration testing of FAA systems; and expanding the scope of penetration testing to include enterprise-level testing.

OUTCOME 06

UNMANNED AIRCRAFT SYSTEMS

FAA Outcome Manager: Mr. Joseph Morra

CAASD Outcome Leader: Michelle Duquette

Outcome Statement: A transformed NAS and NextGen system that:

- Meets national goals for the safe and efficient integration of UAS into non-segregated airspace.
- Balances the access needs of a diverse set of aviation system users.
- Maintains the highest levels of system safety and security.
- Implements standards for safe operation of UAS without compromising safety or efficiency of the NAS.
- Institutes safety assurance and cybersecurity processes as an integral part of normal operations.
- Utilizes metrics to proactively detect issues prior to incidents or accidents.
- Leverages the collaboration of operational experts across the agency and research into technologies and capabilities to improve safety and efficiency of UAS integration into the NAS.

Highlighted Accomplishments

UAS Research Identification Framework

The UAS domain is an extremely fast-paced evolutionary shift. To create enabling policy, the FAA must have a strong understanding of intended operations, technologies, and the airspace where these differently performing aircraft will fly. The UAS Research Identification Framework (URIF) is a cloud-based prototype designed to logically calculate and illuminate critical decisions, decision makers, and gaps associated with systemic risk, certification, and operational approval across UAS and AAM integration research pipelines through an FAA lens of responsibility.

This technology serves as a repository and recommendation capability for UAS Research, Engineering, and Analysis Division (AUS-300) leadership, who are responsible for analysis, management, and status tracking of UAS and AAM research activities published within the FAA's UAS/AAM Integration Research Plans. These research plans support the FAA's path to enabling policy and rulemaking decisions.

FY22 ACCOMPLISHMENTS: CAASD successfully integrated URIF into the FAA's EIM development environment, enabling expanded enterprise accessibility to authorized FAA users, direct auto generation of UAS/AAM Integration Research Plan content and reports, and development of an automated software security test suite.

FY23 PLANS: Following leading practice, CAASD will transfer the technology into the FAA EIM system, establishing a core enterprise service supporting UAS/AAM research planning and prioritization.

FY24 – 26 THREE-YEAR LOOK-AHEAD: This work will conclude upon final tech transfer.

Counter Unmanned Aircraft Systems (C-UAS)

The FAA's UAS Security Division (AXE-U00) is evaluating UAS mitigation technologies to better understand the potential impacts of these systems on safe airport operations, navigation, air traffic services, and the safe and efficient operation of the NAS. CAASD's role is to provide modeling, testing, evaluation, and subject matter expertise of both the UAS detection and mitigation systems along with the proposed environments; to assess the mitigation systems at selected airports; and conduct airport risk assessments.

FY22 ACCOMPLISHMENTS: CAASD evaluated the RF radiation and performance of three UAS mitigation systems against performance metrics developed by the FAA's Spectrum Office and the Special Temporary Authority (STA) granted through the Federal Communications Commission (FCC) through either anechoic chamber or on-location open-air

testing. CAASD provided the results of these tests to AXE-U00 to inform progress and potential paths forward of the program and to inform the cooperative research agreements between AXE-U00 and the UAS mitigation system manufacturers. This work has informed performance refinements of the UAS mitigation systems to minimize potential impacts to the NAS and stakeholders and to comply with FAA testing metrics and the FCC STA.

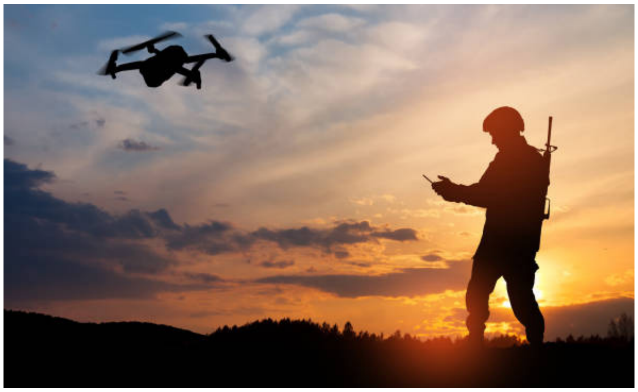
FY23 PLANS: CAASD will continue to test and evaluate UAS mitigation systems (in accordance with Section 383 of the FAA Reauthorization Act of 2018) to inform the program, industry, and the aviation rulemaking committee, along with providing an analysis of stakeholder impacts and an assessment of the associated risks.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to partner with the FAA and other federal agencies to ensure the safe integration of UAS mitigation technologies that minimize impact on NAS stakeholders and operations.

This work has informed performance refinements of the UAS mitigation systems to minimize potential impacts to the NAS and stakeholders.

DOD UAS Traffic Management (UTM) Concept of Operations

The Department of Defense (DOD) Office of the Under Secretary of Defense, Sustainment and Acquisition, has requested access to CAASD's collection of NAS expertise to help realize the DOD vision of adding drone capabilities in support of the warfighter. A critical enabler is an ability to train soldiers on how to safely use drone assets while conducting wartime training within U.S. airspace. Therefore, compliance with FAA plans for UAS/AAM integration has become a DOD priority. CAASD's role is to apply current UAS/AAM NAS integration practice to DOD concepts, discover policy-related challenges of executing DOD UAS missions within the NAS requiring cross-government decision making, and delivering recommendations to accelerate DOD mission execution planning.



FY22 ACCOMPLISHMENTS: CAASD served as both a strategic advisor and connector to establish DOD relationships with both FAA and Industry leaders of UAS integration. CAASD also served as a system-of-systems engineer, bringing leading technical practice and lessons learned to DOD modeling and simulation exercises. Doing so has enabled DOD to restructure its UTM ConOps initial version to better align with NAS integration planning and forge a more realistic path to accelerated mission execution.

FY23 PLANS: CAASD will provide a path for DOD to publish version 2 of its DOD UTM ConOps by working across federal stakeholders to refine mission integration intent, identify NAS enabling policy challenges, and provide leading technical practice recommendations.

FY24 – 26 THREE-YEAR LOOK-AHEAD: CAASD will continue to partner with DOD and other federal agencies to align federal UAS mission needs with enabling policy and technology recommendations through mission enabler discovery, NAS UAS evolution planning, and leading industry practice application.

UAS and AAM for States

CAASD is currently serving as a trusted advisor to state governments (North Dakota, Massachusetts, and Kansas), exemplifying the opportunity associated with state sponsors in UAS and AAM. Our goal is to continue to engage impact growth to create new business and increased our impact. The engagements align with MITRE's good growth strategy to expand our engagement and to impact with state and local governments in the UAS and AAM industry. Additionally, the engagements are aligned with the FAA's mission to further develop long-term relationships that result in MITRE being a critical partner to state leadership in the safe integration of new aviation entrants, preventing national disharmony.

FY22 ACCOMPLISHMENTS: CAASD was both a strategic advisor and technical expert in supporting the State of North Dakota's Vantis program and the Commonwealth of Massachusetts' UAS Beyond Visual Line of Sight (BVLOS) operations.

For the North Dakota Vantis program, CAASD supported the development and implementation of the cross-state UAS BVLOS system. CAASD provided technical assistance in FAA regulatory approaches, system requirements development, strategic planning and implementation, and served as a strategic advisor to the Program Office and the Executive Director. Additionally, CAASD supported the Governor's Autonomy Program in the strategic planning, assessment, and development of the state's path forward as it seeks to be the leader in autonomous development and operations.

For the Commonwealth of Massachusetts, CAASD worked closely with the Massachusetts Department of Transportation (MassDOT) Aeronautics Division for the advancement of UAS BVLOS operations. CAASD also provided technical assistance in FAA regulatory approaches, system requirements development, strategic planning and implementation, and served as a strategic advisor to the Director of Aeronautics.

Additionally, CAASD put in place a multi-year contract with the State of Kansas Department of Transportation (KDOT) to provide technical assistance in FAA regulatory approaches, system requirements development, strategic planning, and implementation, and served as a strategic advisor to the Director of Aeronautics in the areas of UAS BVLOS operations and AAM.

FY23 PLANS: In FY23, CAASD plans to continue to strengthen relationships with state sponsors in support of UAS/AAM efforts.

CAASD is currently in discussions with the State of North Dakota for the continuation of the sponsor engagement through July 2025. CAASD is also in discussions with the Vantis Program Executive Director regarding the continuation and expansion of CAASD's support to the Governor's Office for the Autonomy program.

CAASD will engage with MassDOT to renew MITRE's Master Service Agreement to continue through June 2024. MITRE plans to expand its engagement to include AAM initiatives.

CAASD will initiate support for KDOT in the development and implementation of key infrastructure in support of the state's initiative to provide UAS BVLOS and AAM operations throughout Kansas.

FY24 – 26 THREE-YEAR LOOK-AHEAD: MITRE plans to continue to strengthen and expand relationships with both current and potential state sponsors in support of UAS/AAM efforts. The goal of this effort is to expand the MITRE footprint with state governments in alignment with our FFRDC good growth strategy in the areas of BVLOS operations and implementation, and AAM strategy and implementation planning and integration.

Plans for FY 24-26 include working with key potential sponsors and strengthening the MITRE brand through public engagements. The effort will include performing a targeted landscape analysis of state and industry activities and cross-check with the FFRDC role. The effort will include further refinement of MITRE's unique value proposition and the coordination across MITRE. This effort will enable the expansion of current sponsor activities and the development of new sponsor relationships and long-term engagements.


AOC Futures Lab

OUTCOME 07

SPECIAL STUDIES, LABORATORY, AND DATA ENHANCEMENTS

FAA Outcome Manager: Ms. Marie Sharpe

CAASD Outcome Leader: Ryan Huleatt

Outcome Statement: Execute cross-cutting management and technical activities that improve effectiveness of the individual CAASD Outcomes, address key issues as directed by FAA senior management, and inform cross-cutting capability evolution. Enable objective FAA decision making by providing a system of cost-effective, agile, and innovative research and development capabilities to the CAASD Outcomes.

Highlighted Accomplishments

IDEA Laboratory

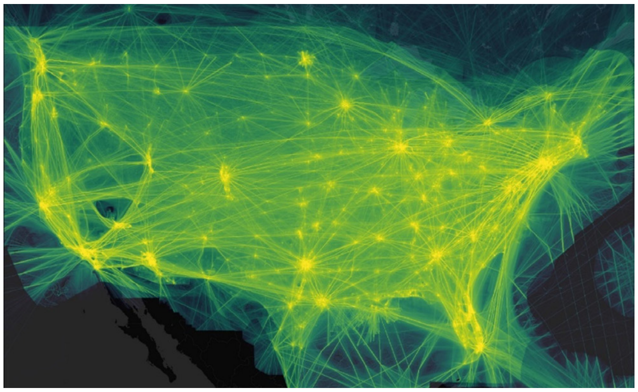
The IDEA Lab provides real-time capability for Human-in-the-Loop (HITL) experimentation and research including concept development, demonstration, and consensus building. It consists of a persistent set of curated, interoperable real-time laboratory capabilities used by CAASD projects that accelerate delivery of high-quality experiments and demonstrations. This includes the set of core simulation services: simulation configuration and execution, simulation data transfer and interfaces, data collection, scenario generation, vehicle modeling, and visualization that are essential to all real-time simulations. It also includes a comprehensive collection of composable transportation system models: En Route Automation Modernization (ERAM), TFM System (TFMS), TBFM, TDFM, STARS, and Airport Surface Detection Equipment System (ASDE-X), along with communication and flight deck systems that can be used to fulfill project needs.

FY22 ACCOMPLISHMENTS: The IDEA Lab maintained consistent availability, achieving 99% availability throughout the year. It hosted 15 major lab evaluations over 55 days. Additionally, it continued to increase its support of remote/distributed events leveraging MITRE's Networked Experimentation, Research, and Virtualization Environment for six HITL events. The team continued their collaboration with FAA laboratories through upgrades to the Simulation Command, Control, and Communication (C3) infrastructure, which was used by the WJHTC as well as DataComm test and evaluation experiments with the FAA's Mike Monroney Aeronautical Center (MMAC). Enhancements include new scenario generation capabilities leveraging the TDP and improved flight modeling fidelity with a focus on aircraft ground handling.

FY23 PLANS: The team will continue to ensure the IDEA Lab and Real-Time Simulation capability are ever ready to meet the work program's experimentation and demonstration needs. This includes continued focus on both in-person and remote/distributed experimentation to enable greater flexibility in stakeholder engagements. The team will focus on continued fidelity enhancements to flight modeling capabilities, expanding tower capabilities, and continued work on scenario generation services and capabilities to support a broader set of simulation and analytic capabilities, both internally and externally.

FY24 – 26 THREE-YEAR LOOK-AHEAD: In the upcoming years, the IDEA Lab will continue to increase its fidelity in real-time flight modeling as well as vehicle ground modeling, enabling increasing accuracy in performance assessment. Additional enhancements to flight models will better represent a diverse set of users and vehicle types for future NAS operations. Broadening simulator representation will enable evaluation and enhancement of safety innovations for rotorcraft and other user types. Additionally, the IDEA Lab plans to continue its investment in remote and hybrid simulation environments to increase and enhance engagement with ATC facilities as it uses its enhanced interoperability capabilities to evaluate complex multi-domain environments in the NAS.

Transportation Data Platform

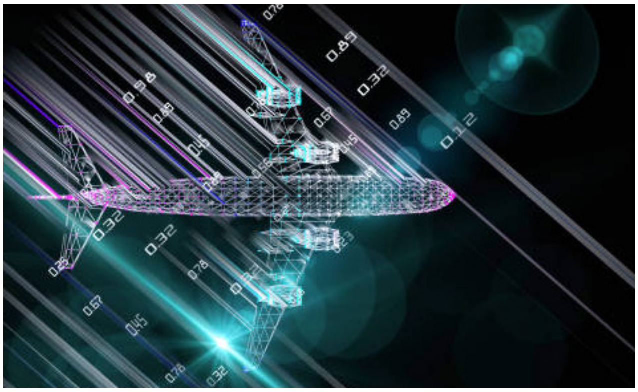


Aviation systems produce large, complex data sets that, when leveraged correctly, can enable evidence-based decisions. However, most stakeholders face significant challenges extracting and processing these data sets to generate meaningful indicators to support decisions. The TDP uses sophisticated methods and tools developed to understand current operational realities, track events of interest (e.g., safety, capacity, and efficiency), infer relationships between events, monitor system effectiveness, and predict the effectiveness of changes.

TDP offers a set of expertise, capabilities, and products provisioned within a comprehensive ecosystem that allows users to quickly build big-data analytic systems that can ingest, integrate, and transform data, regardless of type or volume, into a set of coherent, fused data assets. The power of TDP comes from its ability to be used and reused to jumpstart the development and deployment of domain-specific applications or products. The most recognized of these is the CAASD Threaded-Track and Flight Story, which integrates petabytes of data from over 50 data sets into a threaded track for each flight operating in the NAS over the past 10 years.

FY22 ACCOMPLISHMENTS: To meet CAASD and MITRE's business needs, the team continues to produce 100+ interrelated analytics daily. Architecture and operational enhancements focused on increasing automation to reduce the effort required to produce the platform analytics as well as exploration into transitioning TDP data operations to a cloud environment. TDP data and services were integrated into MITRE's CRE to enable the FAA and its partners direct access to the platform. Existing TFM analytics were enhanced to enable analysts to evaluate how issued Traffic Management Initiatives (TMI) impact flight timelines and measure flight compliance. Route deviation analytics were enhanced to enable analysts to identify and explore when an aircraft is not following their flight plan, and TDP's NAS infrastructure data sets were expanded to include ground obstacles and fixes. CAASD also developed a cloud-native streaming system that provides near real-time data to projects leveraging data from TDP and FAA SWIM services to enable prototyping of near real-time applications. Lastly, CAASD developed new user tools and service enhancements to enable analysts to more easily engage with the vast amount of TDP data to address the FAA's mission needs.

TDP allows users to quickly build big-data analytic systems that can ingest, integrate, and transform data into a set of coherent, fused data assets.



FY23 PLANS: The team will continue to sustain TDP as a comprehensive aviation data product through improvements to day-to-day operations and by continuing to evolve the architecture to support the work program's needs. Empowering analysts and developers to leverage TDP data and capabilities in their work will be enabled by an increased focus on documentation, data catalogs, and improved access mechanisms. The TDP team will continue to expand the data and services available in the CRE and will work to establish more cloud-native operations. The team will continue to enhance and document the streaming services to enable more projects to prototype near real-time applications. Leveraging the AI/ML infrastructure established within the CRE in FY22, the use of TDP data in AI/ML model development will also be a focus.

FY24 – 26 THREE-YEAR LOOK-AHEAD: Going forward, the TDP team will continue to focus on stewarding the platform to ensure the work program's data needs are met through continuous improvement of operations. This will be accomplished by investing in more automation and transitioning to cloud-native workflows. The team also strives to enable a shared stewardship model so that the platform can scale to additional teams that own and operate their respective analytics for the benefit all projects. New data sets and analytics, streaming services, and the development of reusable AI/ML models and workflows will continue to be a focus as the platform continues to be enhanced and evolved.

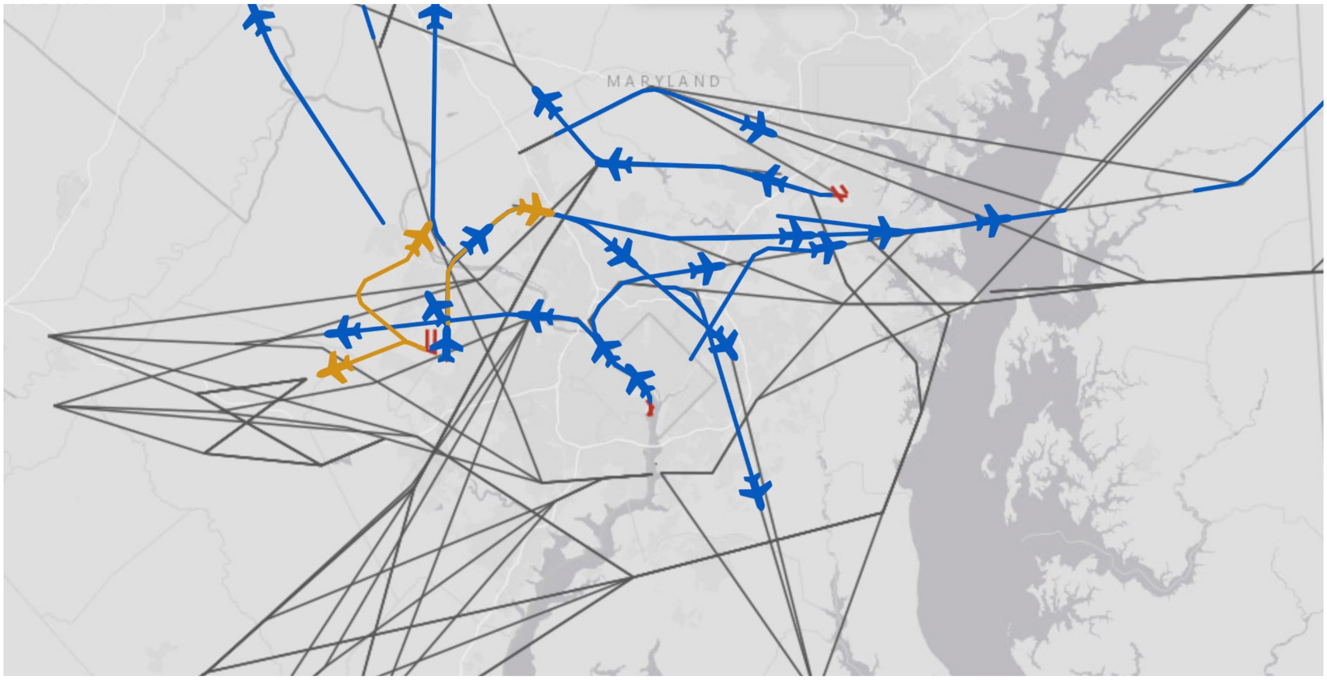
Simulation Platform

The Simulation Platform provides fast-time simulation capability for exploring NAS changes. It enables composition of models from collections of tested, interoperable components, ensuring a consistent modeling approach and subsequently coherent recommendations across the CAASD work program. By simulating the resolution of demand-capacity imbalances, this capability provides insight about the aggregate and network effects on throughput and delay of new technology, procedure changes, redesigned airspace, and operational changes.

By simulating the resolution of tactical traffic problems, users address the same types of changes with the ability to meaningfully interpret more details of simulated behavior. This capability has supported benefits assessments, airport capacity studies, airspace redesign assessments, evaluation of NAS system enhancements, and as a training environment for ML models.

FY22 ACCOMPLISHMENTS: The Simulation Platform was used to study a range of concepts and operational changes in FY22 in support of FAA research questions. Example experiments involved studying new concepts, including MARS, as well as the effects of ground delay programs, airspace flow programs, and time-based management at major airports in the NAS. The platform was also used to evaluate the performance of AI-generated traffic management actions as part of Mission Oriented Investigation and Experimentation (MOIE) research.

These experiments were possible because of enhancements to the platform's fidelity, performance, available models, and scenario generation capabilities that help ensure NAS operations are modeled accurately and



efficiently. The platform documentation and analyst tooling were also improved to enable more projects to leverage the platform for their diverse fast-time simulation needs.

FY23 PLANS: The team will focus on enhancements to model demand-capacity imbalances to inform both strategic and tactical planning contexts as part of what-if analyses studying the effects of different TMIs. Integration into the CRE will enable analysts and sponsors to engage with the capabilities while enabling integration with other capabilities and our data services. Lastly, larger-scale simulations with more aircraft and more complex scenarios will be pursued while ensuring that suitable simulation runtimes are still achieved.

FY24 – 26 THREE-YEAR LOOK-AHEAD: It is our intention that the Simulation Platform will continue to be leveraged by CAASD and others for fast-time simulation needs. To support that usage, we will continue to extend what the platform can represent and how well by leveraging the platform's extensible architecture and modeling paradigm as motivated by mission needs and informed by user and sponsor experiences.

A major emerging need for fast-time simulation is to support planning and operational decision making by predicting the effects of candidate TFM actions. Our work to support these use cases and those for related post-event analysis will involve articulating and meeting fidelity, validity, and speed requirements. We will also pursue deployment of the simulation environment where it is accessible to these workflows. Finally, we will continue leveraging the TDP to efficiently craft simulation experiments.

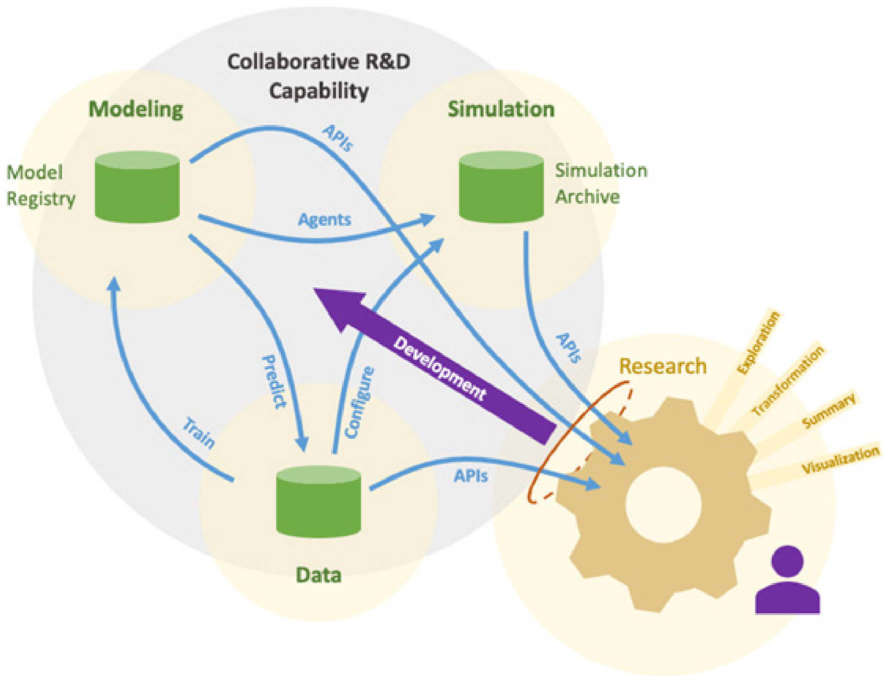
This capability has supported airport capacity studies, airspace redesign assessments, and evaluation of NAS system enhancements.

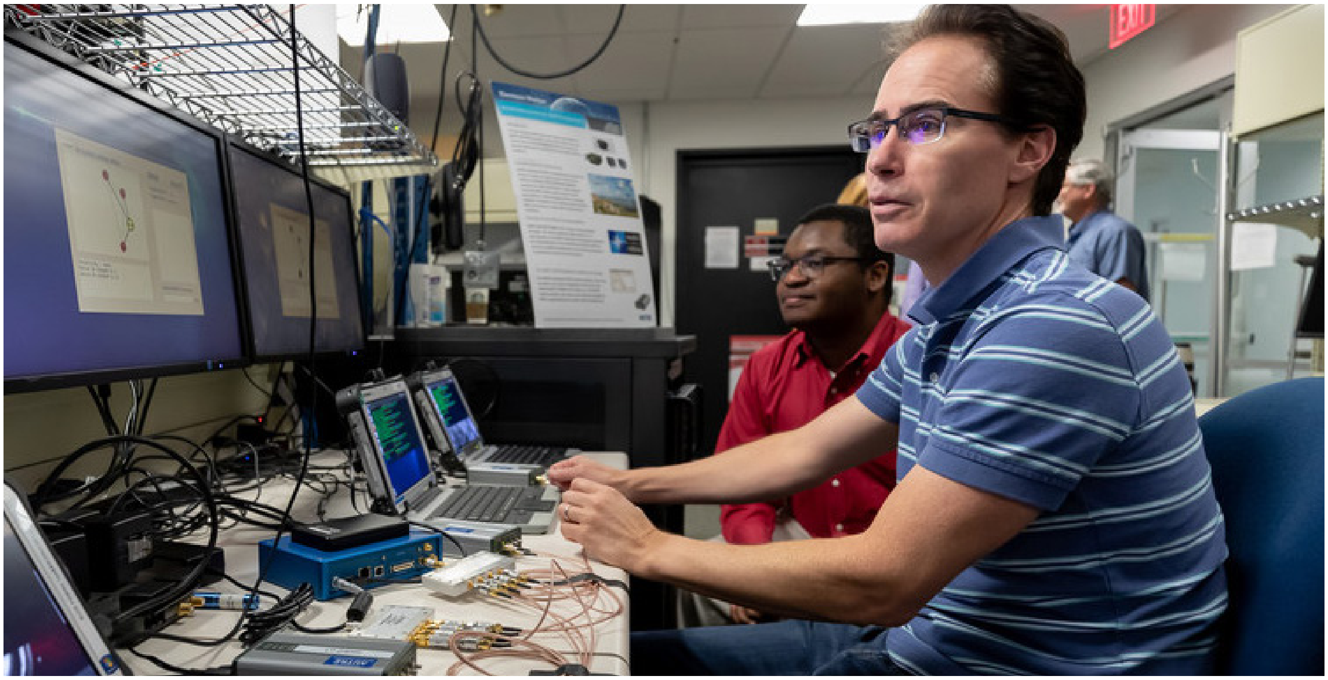
Collaborative Research Environment

The CRE is a secure, cloud platform that enables MITRE to share and collaborate on research with its sponsors and their partners. The goal is to remove barriers to effective collaboration and innovation in a manner that is secure and transparent. Built on a unified architecture, the CRE integrates CAASD enterprise capabilities including the TDP, Simulation Platform, and other CAASD research to streamline teams' abilities to deliver impactful software solutions. Multiple collaboration use cases are supported including mission-focused applications, data analysis, and software development/architecture.

The CRE uses industry standard technology and is compatible with FAA information technology to facilitate streamlined technology transition of MITRE research to our sponsors.

FY22 ACCOMPLISHMENTS: The CRE architecture evolved to better support cloud native development. This was done by establishing consistent workflows, practices, technology, and associated tools to enable teams to build and deploy their capabilities in the platform. This included a migration of our cloud resources to an infrastructure-as-code approach to enable automated deployment and testing, deployment of monitoring tools to assess platform health, and provisioning of development sandboxes for teams to work independently within the platform. AI/ML infrastructure was developed, including an integrated model registry and streamlined development and deployment pipelines that enable researchers to train new models and share them with others more easily. These development platform enhancements enabled more teams to integrate their capabilities within the





CRE for their sponsors to access and led to increased participation by our sponsors and their partners. The user experience within the CRE was also improved by leveraging MITRE corporate authentication services, improved onboarding documentation, and the migration from the AWS Public Cloud to AWS GovCloud, which enables interoperability with our sponsor cloud environments.

FY23 PLANS: The CRE will continue to make improvements to its developer platform, tooling, and documentation to enable more teams to deliver their research within the platform and effectively collaborate with their sponsors. System security continues to be a priority, with the goal of obtaining approval for the storage of Controlled Unclassified Information (CUI), which will expand the project work the CRE can support. CAASD and the FAA will also collaborate on cloud-to-cloud interoperability to enable data and capabilities to transfer between cloud environments, which will support new use cases and streamline technology transfer.

FY24 – 26 THREE-YEAR LOOK-AHEAD: The CRE will continue to mature and support more project teams to deliver research and effectively collaborate with their sponsors. Co-development and collaboration on software and data analysis research will become more common across the work program, and technology transition will be streamlined for research capabilities that are ready to transition into FAA operations. The suite of capabilities within the CRE will continue to grow to support the needs of the work program, with a focus on integration across data, models, and services to answer the FAA's largest and most complex research problems.

The CRE architecture evolved to better support cloud native development.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The MITRE Corporation

OUTCOME

08

MISSION-ORIENTED INVESTIGATION AND EXPERIMENTATION

FAA Outcome Manager: Mr. John Maffei

CAASD Outcome Leader: Dennis Sawyer

Outcome Statement: An FFRDC that prepares the FAA for future needs by:

- Fostering and maturing innovative solutions to system problems to streamline regulatory and Air Navigation Service Provider (ANSP) operations.
- Identifying future technologies, understanding their benefit or disruption to the air traffic operation, and formulating clarity and focus on a path forward.
- Developing the skills and tools needed to analyze and engineer the future NAS.

Background:

The CAASD sponsoring agreement recognizes the importance of innovative, future-looking research and analysis, and establishes a mechanism for conducting that research.

Within the FAA Base Work Program, this independent research program is known as the MOIE program. The FAA and CAASD jointly define the MOIE work program prior to the start of each fiscal year.

CAASD and the FAA develop the research and development program so that it is comprised of projects that are mission-focused, transformative, unproven, and conducted collaboratively with government, research organizations, and private industry.

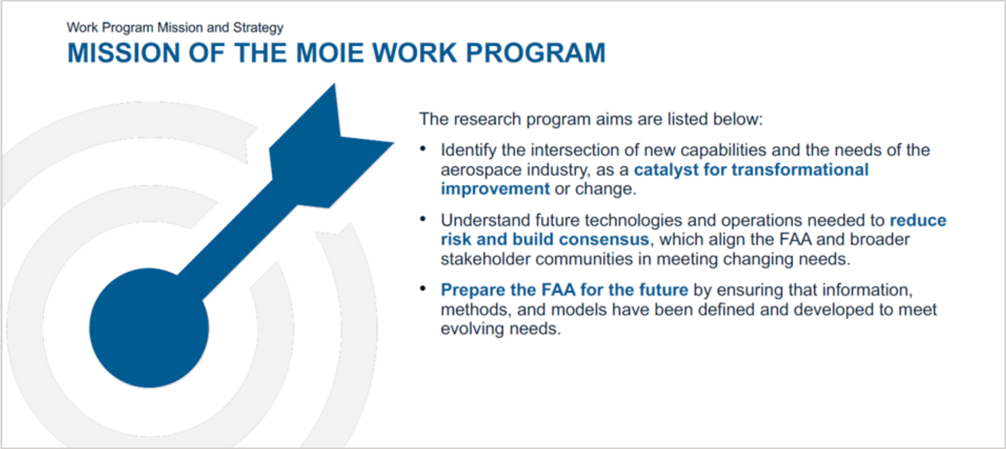
During 2022, the research portfolio consisted of nine independent research and development projects. These projects were conducted to advance the three key missions of the work program: innovating solutions, formulating clarity and focus, and preparing the FAA to engineer the future.

The nine FY22 MOIE research projects included:

- Predictive Analytics for In-Time Safety Alerting
- Certifying Pilot Use of Installed Hardware
- Synthetic Data Generation of Flight Data
- Performance and Risk-Based Strategic Deconfliction
- Design Structure Matrix for Aviation Roadmap Development
- ATM Operational Resilience in a NAS Network Model
- Harmonizing Trajectory Operations on the Flight Deck
- AI-Enabled Traffic Flow Management
- Trajectory Prediction Engine

The FY23 MOIE portfolio will focus on:

- Realizing the next level of safety by identifying emerging risks, enabling actional mitigations, and revolutionizing certification.
- Advancing the future vision by exciting R&D and speeding the development of needed services and capabilities.



FY22 Highlight

AI-Enabled Traffic Flow Management

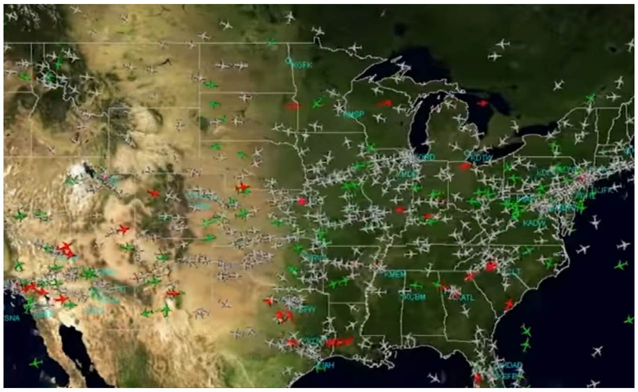
Strategic TFM aims to mitigate future traffic demand in excess of predicted airspace and airport capacity, at look-ahead times when the primary sources of congestion are characterized by significant uncertainties. Despite improvements to the data and decision support tools available, the current TFM decision-making process struggles to account objectively and systematically for uncertainty. Decisions are largely based on the individual traffic manager's experience, resulting in solutions that can remain subjective, inconsistent, and potentially inefficient. While human experience is essential to developing nuanced solutions, the complexity of the data and system dynamics merits an analytics-driven approach to obtain the repeatability, agility, and efficiency desired.

FY22 ACCOMPLISHMENTS: CAASD built on the previous year's AI-enabled TFM work by developing an AI-based automation that provides real-time recommendations of TMIs (including specification of timings and rates) that objectively account for forecast uncertainty. In addition, we successfully implemented an Expert Iteration (ExIt) algorithm to train a neural network, demonstrated improved recommendations over a baseline search algorithm, and implemented an approach to assimilate capacity observations into the forecast, improving predictions and the resulting TMI strategy design.

Given the complexity and opacity of AI-based automation, it is important that future users can understand and ultimately gain trust in the recommendations provided. As such, our FY22 research also identified requirements for a future AI-enabled TFM decision support capability that enables effective human-machine teaming.

FY23 PLANS: CAASD will develop additional AI-based models that strengthen and complement our initial approach. Specifically, we will research and construct learned models that: (1) improve the representation of weather forecast uncertainty to increase predictability in the recommendations generated; (2) reduce the dimensionality of the problem by directly capturing physical and dynamic properties in the representations; and (3) highlight underlying scenario features that support the recommendations and build confidence with users. In addition, supporting analyses will seek to refine the metrics used to generate recommendations and classify scenarios, resulting in improved and operationally valuable solutions. Together, the output will be a comprehensive plan for enabling strategic TFM automation in line with info-centric NAS objectives.

FY24 – 26 THREE-YEAR LOOK-AHEAD: An AI framework for designing TFM strategies provides the FAA with a demonstrable approach for improving both the efficiency of NAS operations and the repeatability of performance outcomes under challenging circumstances. Through this novel application of AI, the research will provide important insights into the readiness of such technologies and inform critical research areas required to more broadly support the FAA's focus on automation-assisted, data-driven technology.




What caused this FOQA unstable approach anomaly?
Over 12 months, unusual increase in event rate and sudden decrease
COUNTS
EVENT RATE
Unstable Approach Potential Causes:
Data quality or missing data?
Fleet change?
ILS outage
Procedure/Approach changes?
High headwind, tailwind, crosswind?
Runway closure?
Fusion Flight Story
ASIAS Secure Fusion Architecture Overview
Panasonic

VALUE-ADD CAASD WORK

With FAA approval, CAASD works across the transportation domain as well as with international air navigation service providers and civil-military aviation to share and apply lessons learned, knowledge, and best practices to FAA challenges.

Surface Transportation

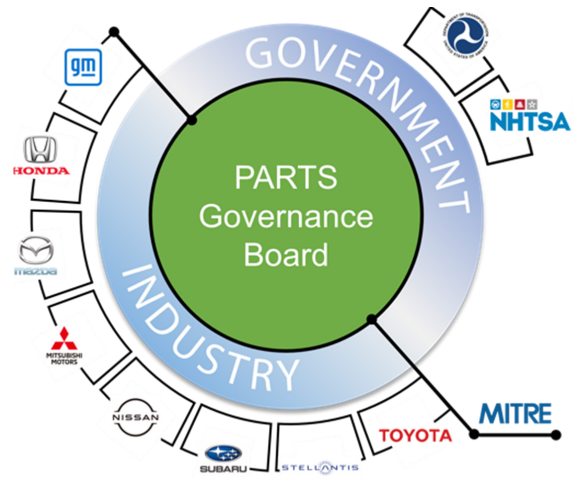
Partnership for Analytics Research in Traffic Safety (PARTS):

PARTS is an independent and voluntary partnership among automobile manufacturers and the U.S. Department of Transportation in which participants share relevant safety-related data solely for collaborative safety analysis. The goal is to gain real-world insights into the safety benefits and opportunities of emerging Advanced Driver Assistance Systems (ADAS) and other safety technologies. MITRE serves as the independent third party.

In November 2022, MITRE released the results of the latest PARTS study, the largest industry-wide study of its kind to be completed to date. The eight participating industry partners that provided vehicle data for this study were Honda, General Motors, Mazda, Mitsubishi Motors, Nissan, Stellantis, Subaru, and Toyota, accounting for more than 65% of the 2021 U.S. market. (Ford has since joined PARTS as a partner.)

The objective of this PARTS study was to explore the real-world effectiveness of six ADAS features in reducing system-relevant crashes, specifically front-to-rear crashes for forward collision warning and Automatic Emergency Braking (AEB) and single-vehicle road-departure crashes for lane departure warning, lane-keeping assistance, and lane-centering assistance. This study combined 13 states' police-reported crash data (2016 to 2021) with vehicle equipment data from 47 million vehicles, representing 93 vehicle models (model years 2015 to 2020), resulting in the study data set of 2.4 million crash-involved vehicles.

One result is that all front-to-rear crashes were reduced by 49% when the striking vehicle was equipped with AEB compared against striking vehicles that were not equipped, and that AEB effectiveness continues to perform well, even when conditions are less than ideal (e.g., in the dark and on wet roads).



The report was posted on www.mitre.org and shared broadly in national publications and throughout the traffic research community. NHTSA uses the results to inform agency policy and decision making related to ADAS features, identify targets for future research, and educate the public. Automakers use the results to assess performance in the field and identify opportunities for improving ADAS effectiveness on their respective vehicle models.

In future iterations, PARTS will expand partners, refine its analytic methods, and conduct increasingly nuanced research to have maximum impact on roadway safety. MITRE will seek to incorporate data from additional partners and states to expand sample sizes and increase the representativeness of the study, as well as explore other data sources, such as vehicle-based telematics, to better understand interactions with driver behavior and on-road infrastructure.

Washington Metropolitan Area Transit Authority (WMATA)/MITRE Partnership:

In March 2022, WMATA partnered with MITRE to strengthen its safety management system. Over the course of a three-year contract, MITRE will work with WMATA to assess its safety culture, develop a plan to improve its safety data analytics, and deploy a secure Voluntary Safety Reporting Program (VSRP). The VSRP will produce data that can be integrated with other WMATA safety information to continuously improve the organization's data-driven safety risk management. Once implemented, the VSRP will lower barriers to safety and hazard reporting and elevate WMATA's safety protocols.

MITRE worked with WMATA to establish a baseline set of safety measures that WMATA will use to monitor its safety evolution over time. Specifically, MITRE designed and administered a safety culture assessment survey to over 10,000 WMATA employees and contractors to gather feedback on 10 key safety culture dimensions. The survey was designed using the MITRE-developed Safety Culture Maturity Model, which is used to assess where an organization is in its journey to build and maintain a strong safety culture. MITRE also conducted stakeholder interviews and focus groups.

Using the survey results and the input from the interviews and focus groups, MITRE provided data-driven recommendations for WMATA to address target areas and gaps identified by the safety culture assessment. The results will be used as one set of inputs to drive requirements for a comprehensive WMATA VSRP. A VSRP is a critical part of a robust Safety Management System (SMS) within an organization and enables the reporting of safety concerns for risk identification and mitigation.

MITRE also worked with WMATA to establish a new WMATA Joint Labor and Management Safety Committee (JLMSC). The JLMSC is responsible for identifying safety deficiencies within WMATA and recommending mitigations to reduce risk associated with identified safety hazards. With this safety committee, WMATA was one of the first transit operators in the country to meet a new regulatory requirement described in the Bipartisan Infrastructure Law changes to 49 U.S. Code § 5329(d).

Finally, MITRE began to define with WMATA the future vision for a voluntary and confidential safety reporting program. This year, MITRE will work with WMATA to define and finalize requirements for its VSRP. MITRE will use the safety culture assessment results and follow-on recommendations as inputs.

MITRE will also begin an effort to transform WMATA's data into safety intelligence by developing a comprehensive analytics and data management strategy. This strategy will help WMATA design an infrastructure that will use data to meet its analytics objectives.

As WMATA implements the VSRP and strengthens safety practices based on MITRE recommendations from the FY22 safety culture assessment, MITRE will measure changes in WMATA's safety culture by assessing it again in FY24. Results of this follow-on assessment, which will use the same questions as the baseline assessment, will inform additional WMATA actions to efficiently integrate safety into its day-to-day operations.

Once the WMATA VSRP is operational, MITRE will work with WMATA to provide operations and maintenance assistance to ensure that the VSRP meets its goals. MITRE will also advise WMATA of any refinements to the VSRP to ensure it addresses safety concerns as intended. Finally, MITRE and WMATA will together develop a plan to fully transition operations and maintenance of the VSRP capability from MITRE to WMATA.

Civil-Military Integration

DOD UAS Traffic Management: Drone Traffic Management Capability

MITRE leveraged its CAASD and National Security Engineering Center (NSEC) FFRDCs to form a cross-center, multi-domain team focused on developing functional requirements to enable the DOD to plan for acquisition and development of drone traffic management capabilities. In 2020, the DOD asked NASA to develop UTM ConOps for the DOD. In 2021, the DOD asked MITRE to work with NASA to further refine this concept.

MITRE worked with the DOD sponsor and NASA to jointly determine the DOD-needed functional requirements rather than a traditional ConOps. As a result, MITRE drafted a set of functional requirements for the DOD to perform as a UAS Service Supplier (USS) in the UTM ecosystem. UTM is envisioned to be how airspace will be managed to enable multiple drone operations conducted BVLOS, where traditional FAA air traffic services are not provided (this is typically below 400 feet).

The FAA UTM ConOps proposes a federated model where industry's ability to supply services is leveraged under FAA's regulatory authority. The DOD wishes to participate in this ecosystem as a federal USS operating its own UAS fleets and missions. MITRE's expertise from NSEC was leveraged to identify and delineate those requirements unique to the DOD and other potential federal partners. CAASD's expertise was leveraged to ensure a tight alignment to the existing FAA UTM ConOps to the extent possible for the DOD.

This work is expected to enable DOD to establish its own UTM capability to: (1) operate its own low altitude UAS; (2) support military ATC requirements for low-altitude UAS; and (3) support DOD counter-UAS needs in the NAS and in expeditionary environments.

International

Singapore Convective Weather Impact Forecast

It has been long recognized that Singapore needs advanced aviation weather decision support for more proactive and effective air traffic planning, coordination, and decision making when operating under convective weather constraints.

To help the Civil Aviation Authority of Singapore (CAAS) overcome its operational challenges, CAASD developed ML models to translate unlabeled, wide-area Himawari weather satellite information, centered on the Singapore FIR, into convective weather regions deemed impactful (thus significant) to air traffic operations. This translated convective weather product is the Weather Avoidance Field (WAF).

A WAF represents weather at levels of low to high severity coincident with increased likelihood of flight deviations and traffic disruptions directly due to associated weather encounters. Modeling, generating, and validating the Singapore WAF was the focus of the year 1 effort for this two-year project. The year 1 effort, prototype, and technical report were delivered in December; the year 2 effort to forecast aviation weather hazard product has begun.

SouthPAN Technical Assistance Project

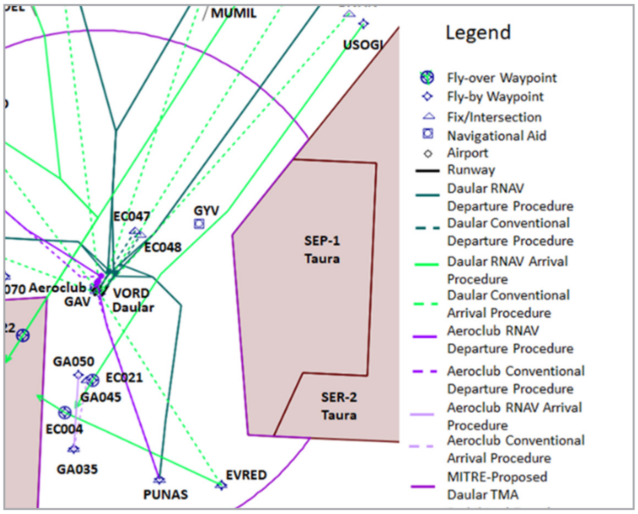
The Southern Positioning Augmentation Network (SouthPAN) is a joint initiative of the Australia and New Zealand governments to provide a satellite-based augmentation system for the two countries. CAASD is providing technical assistance and recommendations for the acquisition and review process for SouthPAN, serving as a technical advisor to help reduce program risks associated with aviation safety. CAASD is reviewing system design, testing, and implementation approaches to support system certification during the SouthPAN implementation phase. Working with the customer, Prime Contractor, and various SouthPAN stakeholders, CAASD will assist with successful acquisition, development, and certification.

Future Three-Runway System at Hong Kong International Airport

CAASD developed flight procedures and airspace design for a three-runway system that achieves the goal of 102 operations (arrivals and departures) per hour within existing (very constrained) airspace. In partnership with Airways New Zealand (an ANSP), CAASD is providing airspace design expertise and human-in-the-loop simulation testing experience; Airways New Zealand is providing implementation support.

Airport Planning in Daular, Ecuador

A new international commercial airport in Daular, Ecuador will replace the existing airport serving the city of Guayaquil, Ecuador, the country's second largest city after its capital, Quito. CAASD is the lead aeronautical analyst serving the Autoridad Aeroportuaria de Guayaquil (AAG) to construct an airport consisting of two parallel runways capable of conducting dual independent approaches and departures. An "AeroClub" next to the new Daular Airport is going to be built for pilot training, and operations will take place alongside the international airport, raising the project's complexity and operational safety. CAASD's procedural development and other analyses demonstrated the feasibility of the project. An AAG-coordinated independent audit complimented MITRE on the excellence of its technical work.

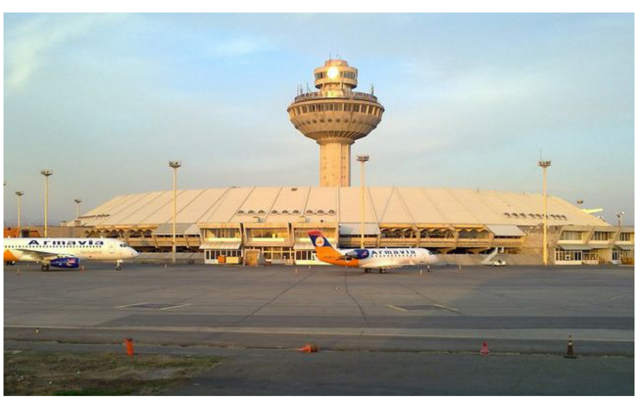


Mexico

MITRE completed the modernization of an “intelligent” air traffic controller training device and is designing and preparing a Mexico City site for the device’s installation. No live pilots are required, resulting in significant savings. The device is also bilingual.

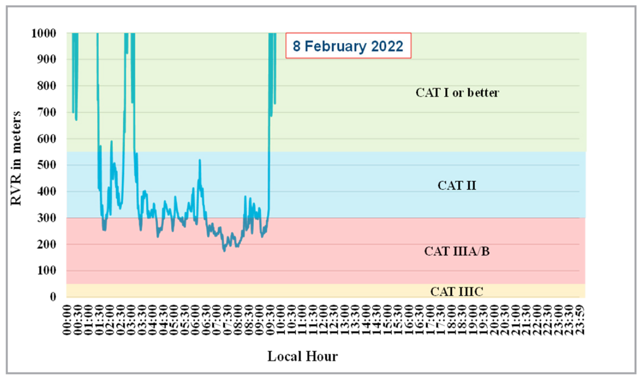
Future Runway Procedures: Armenia

MITRE has developed a second runway utilizing instrument approach and departure procedures per ICAO at Zvartnots International Airport in Yerevan, Armenia.



Israel

MITRE created and delivered to the Civil Aviation Administration of Israel estimates of airport noise contours and a sophisticated weather analysis around a future extension of an air base in northern Israel. The extension is being designed as a civil airport to complement Ben Gurion International Airport, the main international airport in Israel.




ANSFORMING
E NATIONAL
RSPACE SYSTEM
IMPACT
FROST

INNOVATION AND ACCELERATION

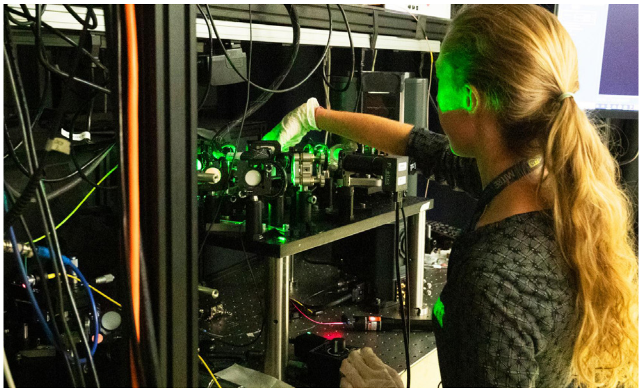
MITRE Innovation Program

In addition to the FFRDC MOIE program, MITRE invests in research across the aviation, aerospace, and surface transportation domains under the MITRE Innovation Program (MIP). MITRE seeks to build toward a safer and more efficient U.S. transportation system by addressing key subjects that pose risks to that future. Some highlights of our FY22 research are summarized here.

GNSS Spoofing Mitigation Using a Peak Suppression Monitor

The Global Navigation Satellite System (GNSS) provides critical Position, Velocity, and Timing (PVT) capabilities to military, civil, and commercial users around the world. Safeguarding the integrity and availability of such systems is a priority for federal agencies such as the DOD, DOT, and FAA. However, these systems are vulnerable to unintentional or malicious interference. One form of intentional interference is spoofing, where synthetic GNSS signals are broadcast to trick a GNSS receiver into using false signals and obtaining an incorrect PVT solution. MITRE has developed a monitor to detect and mitigate such attacks to safeguard a receiver's solution integrity.

The monitor algorithms have been successfully prototyped in several forms, including on an airborne platform for MITRE's work on the Cyber Office for Weapon Systems (CROWS) project for DOD, on an Android smartphone that alerts the user to either spoofing or jamming events, and in a small standalone unit based on a Raspberry Pi minicomputer. All of these have been extensively tested in real-world



(air and ground) contexts and against industry-standard laboratory test protocols. MITRE has filed two patents on this technology and is discussing licensing agreements with several companies.

A robust, low-cost GNSS spoofing detection and mitigation solution would significantly enhance the integrity and availability of critical systems and applications that rely on GNSS signals. It would enhance flight safety; harden vulnerable infrastructure like power grids, roads, and highways; and protect financial markets and banking systems. It would make communication networks more dependable and encourage emerging UAS services and technologies. It would bolster U.S. national security and enable military users and operations around the world.

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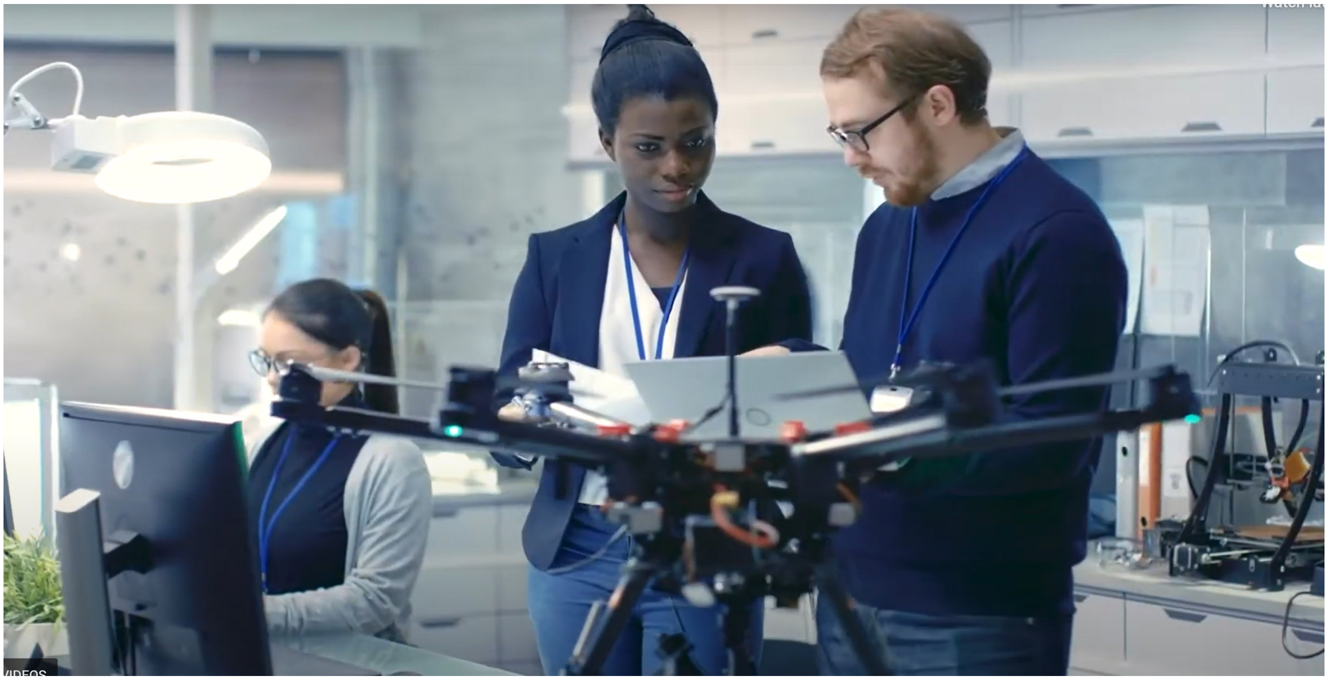

Analytic Safety Guarantees for Autonomous Robotic Devices

As autonomous vehicles become more commonplace, a critical challenge is ensuring their safe operation around manned vehicles, people, and other autonomous systems. To address this need, MITRE has developed and demonstrated Analytic Safety Guarantees for Autonomous Robotic Devices (ASGARD), an approach to mathematically guaranteed safe vehicle autonomy that exploits and extends modern developments in Control Barrier Functions (CBF), differential flatness, and convex optimization. ASGARD permits transparent and simple composition of safety requirements with existing autonomous system behaviors, increasing the pace with which safe autonomy capabilities can be developed and integrated into unmanned vehicle platforms, and providing rigorous mathematical guarantees about the safe operation of the resulting control laws.

ASGARD is an approach to vehicle safety that leverages CBFs to ensure that low-level vehicle control actions do not cause the vehicle to enter any user-defined unsafe states. Briefly, a CBF is a function defined for a system that, if it can be shown to meet certain inequality requirements, guarantees that a system trajectory starting in a region of the safe set will converge to and remain in the safe set. During operation, ASGARD minimally modifies nominal vehicle control commands to ensure that safety conditions are not violated. This approach to safety composition allows for easy integration of ASGARD with almost any type of high-level autonomous behavior, or even human-controlled teleoperation.

In 2022, MITRE developed extensions to ASGARD supporting both quadrotor and fixed-wing Unmanned Aerial Vehicle (UAV) applications, including autonomous terrain avoidance, avoidance of geodetic keep-out areas, and collision-free maneuvers involving multiple autonomous agents. These developments were demonstrated in functional and high-fidelity software-in-the-loop simulations, and development is continuing for deployment on experimental platforms. Additional extensions to ASGARD were formulated and demonstrated in simulation to permit long-duration overhead surveillance of an area of interest by a team of UAV agents. In this application, ASGARD enforces collision avoidance in addition to energy management, bringing vehicles back to a charging area when needed to refuel/recharge while other agents automatically fill in for the missing agent. ASGARD was also integrated and demonstrated experimentally on the MITRE Drone Assisted Radar Target (DART) vehicle platform (autonomous Jeep Grand Cherokee) avoiding static obstacles in a minimally invasive fashion at a variety of speeds.

MITRE's First Responder Drone Range (FRDR) project is currently applying ASGARD to support several safety objectives for both quadrotor and fixed-wing UAV platforms. FRDR is utilizing ASGARD to enable terrain collision avoidance, collision avoidance of UAV teams, and avoidance of geodetic keep-out areas. When completed, these developments will enable safer operation of first-responder drones in rugged environments and reduce vehicle losses due to collision. Starting in 2023, the Army's Ground Vehicle Systems Center will be using ASGARD in its autonomous ground vehicle research activities.

Alleviating Airport Curbside Congestion

Transportation Network Companies (TNC) such as Lyft are a popular method of getting to and from the airport—so popular that many major airports are experiencing large increases in TNC traffic, producing an unprecedented amount of airport curbside congestion. At the same time, airports are experiencing a decrease in demand for taxis, limousines, rental cars, and, most importantly for airport revenues, vehicle parking. This project aimed to create a decision support tool and traffic management strategies that predict and alleviate airport curbside congestion.

A prototype, called FastCurb, was developed that uses live data from flight plans, curbside geometry, passenger transportation modality, and a previously developed curbside utilization model to predict curbside capacity and demand. This tool has been adapted for three airports: Boston Logan (BOS), Newark Liberty (EWR), and Seattle-Tacoma (SEA). In addition, surface traffic management strategies were developed that could help airport authorities manage demand and capacity imbalances, and the team worked with economists to develop choice models. These choice models use parameters such as price elasticity and the value of time to estimate the effect an increase in price, such a congestion surcharge for using the curbside, could have on the traveling public. More specifically, the choice model estimates a proportion of passengers that will opt for arriving

at the airport earlier or waiting longer to leave the airport, thus resulting in demand being spread over a wider timeframe.

The ability to predict atypical demand peaks and have predetermined mitigation actions for implementation can help airport operators maintain acceptable levels of service and avoid operational gridlock. This directly benefits the traveling passenger, and it benefits airport operators, service providers and concessionaires in providing sufficient staffing to meet need without overstaffing. There are other benefits such as reducing NAS system impact from delayed flights, improved airline Estimated Off-Block Times (EOBT) and reduced environmental impacts resulting from more efficient movement of passengers and vehicles. MITRE is working with the Port Authority of New York and New Jersey and the Port of Seattle to evaluate the prototype, with the goal of eventual technology transfer.

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MITRE
SOLVING PROBLEMS
FOR A SAFER WORLD

FFRDC OPERATIONS AND STEWARDSHIP

Governance

The FAA's CAASD Program Manager is responsible for all programmatic actions including, technical oversight, program plan validation and coordination, appropriate work determinations, resource allocation, coordination with the CAASD director's staff, liaison with other government agencies, and contact with industry concerning FFRDC matters.

Day-to-day oversight of CAASD occurs through ongoing interaction between the FAA and CAASD Program Manager, the FAA and CAASD Contracting Officers, and the FAA Outcome Managers (OM) and CAASD Outcome Leaders (OL) and staff performing the work. In addition, the FAA's CAASD Program Manager participates in monthly contract management review meetings to monitor financial and schedule performance and address contractual items.

The FAA's FFRDC Executive Board (FEB), FAA Group of 4 (G4), and the CAASD Program Management Office (PMO) provide overall oversight, guidance, and management for the work program. While each of these entities has its specific roles and responsibilities, collectively they ensure that CAASD focuses on the FAA's most pressing needs.

FEB: The FEB meets semi-annually to prioritize, shape, and evaluate CAASD FFRDC work program.

GROUP OF 4: The FEB created the G4 to ensure a fresh look is independently applied annually to all planned CAASD work. The G4 considers agency shifts in needs and priorities, and ensures that the planned work addresses the most critical problems facing the FAA and the aviation community.

AVIATION ADVISORY COMMITTEE: The MITRE Board of Trustees' Aviation Advisory Committee (AAC) provides strategic advice and counsel through CAASD on key issues that need to be addressed in modernizing the aviation system. AAC members include high-ranking officials from aviation industry organizations and selected members of the board. The AAC meets three times per year, and senior FAA executives regularly participate in the meetings.

OUTCOME MANAGEMENT: CAASD's work program is structured around eight FAA outcomes that reflect the FAA's strategic objectives:

- Outcome 1: NAS Concept of Operations Architecture and Integration
- Outcome 2: ATM Operational Evolution
- Outcome 3: Airspace and Performance-Based Navigation
- Outcome 4: Safety and Training
- Outcome 5: Communications, Navigation, Surveillance and Cybersecurity Infrastructure
- Outcome 6: Unmanned Aircraft Systems
- Outcome 7: Special Studies, Laboratory and Data Enhancements
- Outcome 8: Mission-Oriented Investigation and Experimentation

Each year, the FAA prepares detailed Product-Based Work Plans (PBWP) that define the work, products, and deliverables for each outcome. The PBWP is CAASD's contractual statement of work. It includes work that is funded by the Base budget line item and work funded through Industrial Funding (IF).

Products CAASD delivers to the FAA are also electronically available to all FAA employees via the CAASD

Tracker archive (https://tracker-prod.mitre.org/). Deliverables are organized by outcome according to the work plan for each fiscal year. The work statements are provided in full in each Outcome's PBWP, and the URLs for individual products are embedded throughout the task descriptions. Tracker makes all PBWP information and CAASD products readily available to the agency.

FY22 PRODUCT AND OUTCOME EVALUATIONS: The FAA evaluates CAASD's performance on each outcome semi-annually; evaluates and accepts CAASD's individual products as delivered; reports on product receipt and acceptance monthly; and hosts formal Quarterly Product Review Boards (QPRB).

The FAA evaluates CAASD's *overall performance* by Outcome through semi-annual OM performance evaluations. The OM performance evaluations include FAA stakeholders and beneficiaries' inputs and provide an overall assessment of CAASD's technical, schedule, and resource management of each outcome. Cost management is assessed as part of the evaluation by the FAA's CAASD program manager. The evaluation results are presented to the FEB semi-annually. CAASD consistently receives very high marks in all the evaluation categories.

The two FY22 semi-annual OM evaluations' FY-H1 and FY-H2 responses resulted in the averages (on a 1-to-4 scale with 1 marginal, 2 satisfactory, 3 excellent, and 4 outstanding) shown in the table below.

Technical Performance	3.66	3.82
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Resource Management	3.73	3.82

All CAASD products are evaluated and rated by their cognizant FAA stakeholder reviewer(s) at time of receipt and are individually accepted by FAA's Technical Liaison Officers (TLO). The summary results of these reviewer evaluations are also presented to the FEB semi-annually. Products are evaluated as outstanding, above average, average, below average, or poor. Product evaluations are a valuable element of the FAA's oversight and contribute to CAASD's continued focus on product quality.

In FY22, a total of 336 products (plus 8 supplementals) were delivered. As of December 12, 2022, 177 of the 336 delivered products had received FAA product reviewer grades. The reviewed products received the following grades:

Outstanding	72
Average	25
Total	336

Partnerships

To support the FAA and accelerate the adoption of new technologies and methods, CAASD partners with industry, academia, non-profits, stakeholder organizations, and government to diversify interactions and engagements and maintain an innovative edge.

Partnerships are formalized through non-disclosure agreements; memorandums of understanding; collaborative research agreements; or licenses for intellectual property that enable the broad set of stakeholders to mature new ideas, operationalize concepts or prototype capabilities, and ultimately deliver improved safety, efficiency, and access to airspace users.

Advocacy

A primary objective of CAASD's mission as an FFRDC is to share findings with the broader aviation community, associated government agencies, and members of industry.

CAASD researchers are encouraged to publish key findings, participate in forums and panels, and ensure that they are collaboratively contributing to the broader body of knowledge that will move the transportation domain forward.

Key 2022 Conference Participation

CAASD participates in a broad range of aviation and aerospace conferences each year to both learn and share. CAASD staff are frequent contributors of technical papers and presentations and are often invited to serve as subject matter experts on educational panels and plenary sessions. Key CAASD technical personnel also are regular keynote speakers.

In FY22, CAASD continued to have significant participation in numerous aviation industry conferences, participating in educational webinars and panels and sharing technologies and demonstrations as part of virtual and physical booths. Highlights included:

- ACT-IAC Emerging Innovation Conference
- AIAA: ASCEND, AVIATION, and SciTech conferences
- American Meteorological Society annual meeting
- Association for Uncrewed Vehicle Systems International (AUVSI) XPONENTIAL conference
- ATCA: Joint ATC Conference; Annual Conference
- Digital Avionics Systems Conference (DASC)
- FAA Managers Association (FAAMA) annual conference
- ICAO Triannual Assembly
- InfoShare
- Integrated Communications Navigation and Surveillance (ICNS)
- NATCA Communicating for Safety
- Transportation Research Board (TRB) annual meeting
- World ATM Congress

ICAO Triannual Assembly

MITRE participated in the triannual International Civil Aviation Organization's 41st Assembly in October. In addition to hosting an exhibit booth and demo, MITRE delivered presentations on Aviation Risk Identification and Assessment (ARIA) and Risk-Based Decision Making. MITRE was also the primary contributor to four U.S. Working Papers submitted by the FAA:

- Predeparture Mobile Clearance
- Trajectory Prediction
- Predictive Analytics for TFM

Extended Projected Profile with Connected Aircraf

Featured Content In External Publications

CAASD has content partnerships with several aviation industry publications and frequently shares technical pieces and FAA project success summaries as part of its advocacy role. In addition, CAASD publishes select project stories on www.mitre.org to highlight important FAA mission achievements as well as technical thought pieces and publications. Content is frequently prepared in partnership with and with the approval of the FAA. In FY22, CAASD-provided content appeared in:

- AIAA's *Aerospace America*
- *Air Traffic Technology International*
- *ATCA Bulletin*
- *ATCA Journal*
- FAAMA's *Managing the Skies*
- Civil Aviation Authority of Singapore's *The Leading Edge*
- *Popular Science*

External Recognition

R&D 100 Award

MITRE was recognized in an R&D 100 award along with our partners, Lincoln Labs and Johns Hopkins University Applied Physics Laboratory, for the Airborne Collision Avoidance System (ACAS) for Small Unmanned Aircraft Systems (*Research & Development World* magazine). This award recognized MITRE's contributions to independent safety assessments of every variant of the ACAS X technology to date, to include ACAS Xa (commercial aircraft), Xu (large UAS), and sXu (small UAS). Work has already begun on ACAS Xr (for helicopters). This multi-year work is helping evolve the next generation of aircraft separation systems.

Aviation Laureate Award

Kerry Buckley, MITRE vice president and CAASD director, was selected by Aviation Week Network for its 65th Annual Laureate Awards, honoring her leadership and work to keep space safe and viable. She led the MITRE team that created a space risk registry and management system. Simulating the increasingly crowded environment between the ground and outer space, this system calculates the risk to space operators, indicates where government regulation will provide benefit, and pinpoints where industry could develop best practices without waiting for government.

GLOSSARY

Acronym	Definition
AAAE	Association of Airport Executives
AAC	Aviation Advisory Committee
AAG	Autoridad Aeroportuaria de Guayaquil
AAM	Advanced Air Mobility
ACAS	Airborne Collision Avoidance System
ACT-IAC	American Council for Technology–Industry Advisory Council
ADAS	Advanced Driver Assistance Systems
ADS-B	Automatic Dependent Surveillance–Broadcast
AEB	Automatic Emergency Braking
AES	Automation Evolution Strategy
AFP	Airspace Flow Program
AI	Artificial Intelligence
AIAA	American Institute of Aeronautics and Astronautics
AJR	Office of System Operations
AJR-1	Office of Advisory Circulars
ALA	Office of Labor Analysis
ANSP	Air Navigation Service Provider
API	Application Programming Interface
AQS	Office of Quality, Integration, and Executive Services
ARIA	Aviation Risk Identification and Assessment
ARTCC	Air Route Traffic Control Center
ASDE-X	Airport Surface Detection Equipment–Model X
ASEPS	Advanced Surveillance Enhanced Procedural Separation
ASGARD	Analytic Safety Guarantees for Autonomous Robotic Devices
ASIAS	Aviation Safety Information Analysis and Sharing
ATC	Air Traffic Control
ATCA	Air Traffic Controllers Association
ATCSCC	Air Traffic Control System Command Center
ATM	Air Traffic Management
ATO	Office of Air Traffic Operations
ATOP	Advanced Technologies and Oceanic Procedures
ATT&CK	Adversarial Tactics, Techniques, and Common Knowledge
AUS	UAS Integration Office
AUS-300	UAS Research, Engineering, and Analysis Division
AUVSI	Association for Uncrewed Vehicles Systems International

Acronym	Definition
AVP	Office of Accident Investigation and Prevention
AVS	Office of Aviation Safety
AWS	Amazon Web Services
AXE-UOO	UAS Security Division
BA	Business Aviation
BVLOS	Beyond Visual Line of Sight
C3	Command, Control, and Communication
CAAS	Civil Aviation Authority of Singapore
CAASD	Center for Advanced Aviation System Development
CAST	Commercial Aviation Safety Team
CBF	Control Barrier Function
CDM	Collaborative Decision Making
CJA	Crown Jewel Analysis
CLE	Cleveland Hopkins International Airport
CNS	Communications, Navigation, and Surveillance
ConOps	Concept of Operations
ConUse	Concept of Use
CRE	Collaborative Research Environment
CROWS	Cyber Office for Weapon Systems
CUI	Controlled Unclassified Information
DART	Drone Assisted Radar Target
DASC	Digital Avionics Systems Conference
DataComm	Data Communications
DME	Distance Measuring Operation
DMS	Database Management Software
DOD	Department of Defense
EA	Enterprise Architecture
EFB	Electronic Flight Bag
E-IDS	Enterprise Information Display System
EIM	Enterprise Information Management
EOBT	Estimated Off-Block Time
EPP	Extended Projected Profile
ERAM	En Route Automation Modernization
ExIt	Expert Iteration
FAA	Federal Aviation Administration
FAAMA	FAA Managers Association
FCC	Federal Communications Commission
FEB	FFRDC Executive Board
FF-ICE	Flight and Flow Information for a Collaborative Environment
FFRDC	Federally Funded Research and Development Center
FIR	Flight Information Region

Acronym	Definition
FIXM	Flight Information Exchange Model
FRDR	First Responder Drone Range
FTB	Florida NextGen Test Bed
FTE	Full-Time Equivalent
FY	Fiscal Year
G4	Group of 4
GA	General Aviation
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HITL	Human-in-the-Loop
IaaS	Infrastructure as a Service
IAC	Industry Advisory Council
IARD	Investment Analysis Readiness Decision
ICAO	International Civil Aviation Organization
ICNS	Integrated Communications Navigation and Surveillance
IDEA Lab	Integration Demonstration and Experimentation for Aeronautics Laboratory
IF	Industrial Funding
IFP	Instrument Flight Procedures
IFR	Instrument Flight Rules
IOAA	IFP, Operations, and Airspace Analytics
iTBO	Initial Trajectory-Based Operations
JLMSC	WMATA Joint Labor and Management Safety Committee
JRC	Joint Resources Council
KDEN	Denver International Airport
KDOT	Kansas Department of Transportation
KDPK	Dekalb-Peachtree Airport
LAX	Los Angeles International Airport
MARS	Multiple Airport Route Separation
MASS	More Agile Structure of Services and Service Levels
MassDOT	Massachusetts Department of Transportation
MBSE	Model-Based Systems Engineering
ME	Mission Essential
ME-OE	Mission Essential Operating Environment
MIP	MITRE Innovation Program
ML	Machine Learning
MMAC	Mike Monroney Aeronautical Center
MOIE	Mission-Oriented Investigation and Experimentation
MON	Minimum Operational Network
MOPS	Minimum Operational Performance Standards
MTS	MITRE Technical Staff
NAS EA	NAS Enterprise Architecture

Acronym	Definition
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NATCA	National Air Traffic Controllers Association
NEC	Northeast Corridor
NERVE	Networked Experimentation, Research, and Virtualization Environment
NextGen	Next Generation Air Transportation System
NSEC	National Security Engineering Center
OE	Operating Environment
OL	Outcome Leader
OM	Outcome Manager
OT/ICS	Operational Technology/Industrial Control Systems
PaaS	Platform as a Service
PARTS	Partnership for Analytics Research in Traffic Safety
PBN	Performance-Based Navigation
PBWP	Product-Based Work Plan
PMO	Program Management Office
PVT	Position, Velocity, and Timing
QA	Quality Assurance
QPRB	Quarterly Product Review Board
RA	Resolution Advisory
RNAV	Area Navigation
RNP	Required Navigation Performance
SAFO	Safety Alert for Operators
SBA	Space-Based ADS-B
S-CDM	S-CDM Surface Collaborative Decision Making
SciTech	Science and Technology
SE	Safety Enhancement
SMS	Safety Management System
SOC	Security Operations Center
SouthPAN	Southern Positioning Augmentation Network
SQAE	Software Quality Assurance Evaluation
SRM	Safety Risk Management
STA	Special Temporary Authority
STARS	Standard Terminal Automation Replacement System
SWIFT	SWIM-FAA Industry Team
SWIM	System Wide Information Management
SY	Staff Year
TBFM	Time-Based Flow Management
TBM	Time-Based Management
TBO	Trajectory-Based Operations
TCAS	Traffic Alert and Collision Avoidance System

Acronym	Definition
TDP	Transportation Data Platform
TFDM	Terminal Flight Data Manager
TFM	Traffic Flow Management
TFMS	Traffic Flow Management System
TLO	Technical Liaison Officer
TMI	Traffic Management Initiative
TRB	Transportation Research Board
TTP	Trusted Third Party
U.S.	United States
UAS	Unmanned Aircraft System
UAT	Universal Access Transceiver
UAV	Unmanned Aerial Vehicle
URIF	UAS Research Identification Framework
URL	Uniform Resource Locator
USS	UAS Service Supplier
UTM	UAS Traffic Management
VOR MON	Very High Frequency Omni-Direction Range Minimum Operational Network
VOR	Very High Frequency Omni-Direction Range
VSRP	Voluntary Safety Reporting Program
WAF	Weather Avoidance Field
WJHTC	William J. Hughes Technical Center
WMATA	Washington Metropolitan Area Transit Authority
ZTA	Zero Trust Architecture

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