MITRE: An Overview

Maintaining military strength. Transforming global aviation. Thwarting cyber criminals. Adapting to an evolving healthcare landscape. Responding to citizens' needs efficiently and economically. These are just a few of the critical challenges that our government tackles daily. The MITRE Corporation, a private, non-profit organization, operates federally funded research and development centers (FFRDCs) that help government agencies address many of these challenges.

What We Do

Since 1958, the government has called on MITRE to provide systems engineering, acquisition, and advanced technology expertise. By balancing the need for modernization with the constraints of government spending, we seek to deliver objective, transformational technical guidance in an environment driven by the government's mission, not the marketplace.

Our Organization

MITRE manages multiple FFRDCs and an independent research program:

National Security Engineering Center: Sponsored by the Department of Defense, NSEC supports a broad and diverse set of sponsors within the Department of Defense and the Intelligence Community.

Center for Advanced Aviation System Development: Sponsored by the Federal Aviation Administration, CAASD works to advance the safety, effectiveness, and efficiency of global aviation.

Center for Enterprise Modernization: Sponsored by the Internal Revenue Service and co-sponsored by the Department of Veterans Affairs, CEM aims to support systems integration, engineer better technical solutions, deliver more efficient business processes, and implement new legislative requirements.

CMS Alliance to Modernize Healthcare: The Centers for Medicare & Medicaid Services works with CAMH toward an integrated health system with improved access and quality at sustainable cost.

Homeland Security Systems Engineering and Development Institute: Operated on behalf of the Department of Homeland Security, HSSEDI™ works to safeguard our nation against terrorist threats, aid the flow of legal commerce and immigration, and recover from natural disasters.

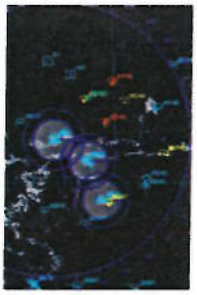
Judiciary Engineering and Modernization Center: Sponsored by the Administrative Office of the U.S. Courts on behalf of the federal judiciary, JEMC provides objective assessments of the technical challenges facing the judiciary, including available and emerging technologies.

National Cybersecurity FFRDC: Sponsored by the National Institute of Standards and Technology, this FFRDC works to enhance cybersecurity and protect national information systems.

MITRE Innovation Program: Our internal R&D program enables our staff to create new technologies or apply existing tools and technologies in innovative ways to meet our sponsors' needs.

MITRE

The FFRDCs that MITRE operates take on tough technical challenges of national importance and provide leading edge, practical, and cost-effective solutions. Here are some examples of recent MITRE achievements.



Rewards of Collaboration

An interdisciplinary team of scientists and engineers from MITRE and Harvard University has taken steps toward ultra-small electronic computer systems that push beyond the imminent end of Moore's Law, which states that the device density and overall processing power for computers will double every two to three years. In a paper published in the *Proceedings of the National Academy of Sciences*, the team described how they designed and assembled, from the bottom up, a functioning, ultra-tiny control computer that is the densest nanoelectronic system ever built.

Research That Evolves Into New Solutions

MITRE launched the National Patient Safety Partnership to improve hospital safety. By sharing sensitive information, aggregating big data, and applying advanced analytics, hospitals can expedite the discovery and elimination of avoidable medical errors—the third leading cause of death in the United States. The inspiration for this partnership came from MITRE's work as a trusted steward to safeguard and analyze sensitive data in the aviation industry. Now it is anticipated that the National Patient Safety Partnership will help the healthcare industry to systematically reduce errors and prevent future occurrences.

Solving Multiple Challenges

Last year MITRE signed a contract with the Civil Aviation Authority of Singapore to establish an office and advanced technology laboratory focused on air traffic management. Air traffic in the Asia Pacific region is expected to triple by 2030. This first-of-its-kind facility—known as MITRE Asia Pacific Singapore—will help the region adapt to the rapidly accelerating demand. By introducing new aviation technologies and procedures, the facility will enable the city-state and its neighbors to maintain a high level of air safety and service.

Sharing Our Research

MITRE cybersecurity experts have developed a powerful new intelligence tool that provides a platform for sharing information about cyber attacks to uncover patterns in an adversary's targets and techniques. CRITs (Collaborative Research into Threats) aggregates, analyzes, and enables sharing of deep technical detail on cyber threats. After proving its effectiveness inside MITRE, CRITs made its public debut when the Advanced Cyber Security Center implemented it in 2011. In summer 2014, MITRE made CRITs accessible to organizations everywhere by releasing it to the open source community.

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Center for Advanced Aviation System Development | FFRDC

Progress in aviation is built on collaboration, innovation, and persistence. These qualities serve as the foundation of our work as we help the Federal Aviation Administration and our other customers plan, develop, and field new capabilities that help modernize air traffic management systems and practices to improve the safety, security, capacity, and efficiency of the global air transportation system.

Resolving Global Aviation Issues through Research and Development

The MITRE Corporation is a not-for-profit organization that operates multiple federally funded research and development centers, including the Center for Advanced Aviation System Development (CAASD) sponsored by the FAA. By conducting an ongoing program of research, development, and engineering in collaboration with the aviation community, CAASD works to advance aviation in the United States and around the world.

MITRE has more than 55 years of experience partnering with the FAA and international civil aviation authorities to modernize air traffic management systems and operations. Our contributions include decision support systems for air traffic controllers and traffic flow managers; communications, navigation, and surveillance systems; procedure and airspace design; operational benefits and capacity analysis; and aviation safety analysis and improvements.

We understand the complex challenges that our customers face. Working in partnership with our customers and other stakeholders, we develop solutions for their most critical needs. We emphasize quality, integrity, and objectivity. This requires a long-term perspective focused on the public interest. We also seek ways to merge operational, technical, and program expertise for effectively deploying and transitioning new and enhanced capabilities.

Dedicated to Improving Aviation Worldwide

In addition to our work for the FAA, CAASD performs work for international civil aviation authorities, airport operators, airlines, and other aviation organizations in more than 50 countries. We also conduct collaborative research with industry and academia. Finally, we help provide training—both in the United States and around the globe—on critically important aviation topics, including safety management system implementation and aviation system block upgrades.

Through our extensive modeling and simulation tools, significant data analytics capabilities, and world-class laboratories, we are able to provide the global aviation community with integrated solutions for new operational concepts and systems.

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Defining the Future National Airspace System

CAASD is providing technical and operational analysis as well as complex concept evaluations to the FAA and the aviation community as part of planning for the Next-Generation Air Transportation System (NextGen). Developing and implementing NextGen is a huge undertaking with many challenges. We are working with the FAA to develop the vision, strategy, operational concepts, architecture, and implementation plans for NextGen.

Improving Aviation Safety

CAASD is developing and applying analytic capabilities to identify and address safety-related issues, with a focus on solving unanticipated problems before incidents and accidents can occur. We understand information system security and airspace operational security, and we are working to improve procedures and systems to mitigate threats and their potential operational impacts.

Improving Airspace Capacity, Performance, and Efficiency

CAASD is developing air traffic management (ATM) decision support concepts and capabilities; communications, navigation, and surveillance (CNS) concepts and capabilities; airport and airspace concepts and designs; and procedural improvements that will enable efficient operations. We understand the complexities and interactions of airspace users' objectives and operations, and we develop methods for measuring and predicting airspace performance. We also identify solutions to improve performance.

Increasing Airport System Capacity

Across the globe, CAASD is assessing empirical data and developing capabilities to identify the location, magnitude, and causes of current and projected future airport capacity shortfalls. We are also developing improvements to use existing airport capabilities and future airport investments more effectively.

Achieving Global Harmonization

CAASD collaborates with the FAA to provide global aviation leadership while ensuring that its evolving plans for ATM/CNS are compatible and aligned with international civil aviation authorities. A key focus involves developing integrated systems in harmony with international standards. As we continue to increase our knowledge of best practices—in areas such as airport safety, airspace design, airport and airspace capacity enhancement, equipage, and ATM—we apply them to the specific circumstances that characterize each country's civil aviation needs.

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Baltimore/Washington International Thurgood Marshall Airport (BWI) Traffic Analysis and Notional Paths Briefing - Abbreviations

ANTHM3 – ANTHM Three arrival procedure (RNAV)

ATC - Air Traffic Control

BWI - Baltimore/Washington International Thurgood Marshall Airport

CONLE3 – CONLE Three departure procedure (RNAV)

DC – District of Columbia

DCA – Ronald Reagan Washington National Airport

ELSO - Equivalent Lateral Spacing Operations

EMI5 – Westminster Five arrival procedure

FAA – Federal Aviation Administration

Ft - Feet

GPS - Global Positioning System

IAD – Washington Dulles International Airport

MSL - Mean Sea Level

MIIDY2 – MIIDY Two arrival procedure (RNAV)

NM – Nautical miles

NATCA - National Air Traffic Controllers Association

OTT6 – Nottingham Six arrival procedure

PALEO3 – PALEO Three departure procedure

PBN – Performance Based Navigation

RAVNN3 – RAVNN Three arrival procedure (RNAV)

RIPKN2 - RIPKN Two arrival procedure

RNAV – Area Navigation

RNP – Required Navigation Performance

Baltimore/Washington International Thurgood Marshall Airport (BWI) Traffic Analysis and Notional Paths Briefing - Abbreviations

RWY – Runway

STAR – Standard Terminal Arrival

SID - Standard Instrument Departure

SWANN3 – SWANN Three departure procedure

TERPZ6 – TERPZ Six departure procedure (RNAV)

TERPZ3 - TERPZ Three departure procedure (RNAV)

TRISH2 – TRISH Two arrival procedure (RNAV)

BWI Traffic Analysis and Notional Paths – Analysis Methodology Summary

From: John Belk (FAA), Bennie Hutto (NATCA)
To: DC Metroplex BWI Community Roundtable Working Group
Date: June 20, 2017

Summary

The FAA asked The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) to conduct analysis of Baltimore-Washington International Airport (BWI) traffic patterns in the Pre- and Post- DC Metroplex time periods. This document summarizes the data sources used, analysis methodology, and available output data contained within the June 20, 2017 briefing to the DC Metroplex BWI Community Roundtable Working Group.

Data Sources

Threaded Track

Threaded Track was used as the source of flight trajectories for the BWI traffic analysis. Threaded Track is a compilation of all available radar surveillance data sources into trajectories that represent true end-to-end flight paths. MITRE CAASD has used Threaded Track extensively for safety, efficiency, and other operational analyses.

Threaded Track is derived from several radar surveillance sources:

- The National Offload Program (NOP) data feed provides coverage at 158 Terminal Radar Approach Control Facilities (TRACONs) and 20 Air Route Traffic Control Centers (ARTCCs)
  - TRACON coverage includes radar reports, usually at a 4.8 second update rate
  - ARTCC coverage, generally reported at a 12 second update rate, includes data directly from En Route Automation Modernization (ERAM) computer systems
- Traffic Flow Management System (TFMS) surveillance data provides one-minute traffic updates and is used to fill in areas where radar data is unavailable
- Airport Surface Detection Equipment, Model X (ASDE-X), a surveillance source that fuses surface movement radar (SMR), airport surveillance radar (ASR), and multilateration to provide surface and low-altitude data at 1 second update rate

Airport, Runway, and Procedure Data

Information on airport and runway location and dimensions is provided by the National Flight Data Center (NFDC). BWI departure and arrival procedure data used within the procedure usage algorithms is available from Jeppesen (a commercial entity) and validated with FAA Coded Instrument Flight Procedure (CIFP) data.

Flight Plan Data

Flight plans and amendments for each flight in the analysis were captured from Traffic Flow Management System (TFMS) data and used to determine departure and arrival procedures.

Analysis Approach

The broad goal of the analysis was to identify changes in traffic patterns at BWI between the Pre- and Post-Metroplex periods (in lateral, vertical, and speed dimensions) and to attribute these changes to causal factors. These causal factors include runway configuration changes, procedure path changes, and ATC operational variations due to vectoring of the traffic. The Pre-Metroplex analysis period was selected as June and July of 2014 (July 11-13, 2014 was excluded due to data unavailability), while the Post-Metroplex analysis period was June and July of 2016. All available trajectory data for BWI flights during these time periods was used for the

analysis. The analysis approach was to evaluate overall traffic changes at BWI, and then conduct further analysis at the runway and procedure level.

Available Output Analysis

Traffic Density Maps

Traffic density maps, with each rectangular cell colored based on average daily number of flights traversing the cell, are used to evaluate changes in lateral traffic patterns. Only cells with at least 50 flights over the two-month analysis period are colored. Comparative density maps, with each cell colored based on Pre- to Post-Metroplex change in average daily number of flights traversing the cell, require at least 50 flights in both two-month analysis periods. For single-day analyses, there is no minimum flight limit.

These density maps were also created for departures and arrivals on each primary runway. To normalize the analysis for differing runway usage frequencies in 2016 vs. 2014 and to isolate Metroplex procedure-related traffic pattern changes, equivalent flight counts were used for the runway-specific density maps (which required randomized reduction of one of the flight samples).

Runway Usage and Procedure Usage Counts/Rates

A runway usage algorithm was used to assign runways to each BWI departure and arrival in Threaded Track data. The algorithm leverages trajectory information, including distance to runway, heading, deviation from centerline, and airborne track point altitude near the ground, to identify the arrival and departure runways for each flight. Runway usage rates over time for BWI traffic are presented in the briefing.

MITRE CAASD developed a procedure usage algorithm to analyze filed or amended procedures and assign each flight to the procedure with highest flight track conformance. This provides the procedure each flight filed and flew. Procedure usage rates for BWI traffic are presented in the briefing.

Lateral Track and Procedure Displays

After observing traffic pattern changes between the Pre- and Post- Metroplex analysis periods within the traffic density maps, track data map displays with respective arrival and departure procedures are used to illustrate lateral path changes. The resultant visualizations contain a randomly-selected 150 flights per analysis period that used the procedures. This is done for visual clarity.

Vertical Track Profiles

Displays of flight altitude vs. lateral track distance are used to demonstrate representative departure and arrival vertical track profiles for each primary runway. Again, for visual clarity, vertical profile displays include 100 tracks per analysis period.

Altitude and Ground Speed Distributions

Altitude and ground speed altitude statistical distributions at 5 NM, 10 NM, and 20 NM from BWI were generated for flights using each primary departure and arrival runway. These distributions, used to identify changes in typical altitudes and speeds, include all BWI departures and arrivals in Pre- and Post- Metroplex periods.

Average Altitude and Ground Speed Maps

These maps show the average altitude and ground speed in the surrounding BWI area, with each rectangular cell colored based average altitude or ground speed for flights traversing the cell. Only cells with at least 50 flights in the two-month analysis periods are colored.

Comparative average altitude and ground speed maps show the location of changes, with each rectangular cell colored based on the Pre- to Post- Metroplex change in average altitude or ground speed for flights traversing the cell. Only cells with at least 50 flights in both two-month analysis periods are colored.