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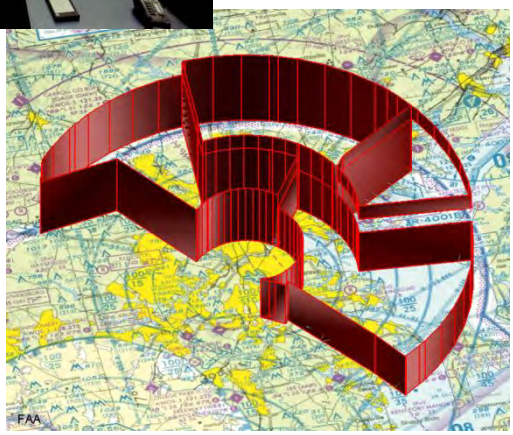
The High Density Departure and Arrival Traffic Management (HDDAM) Concept



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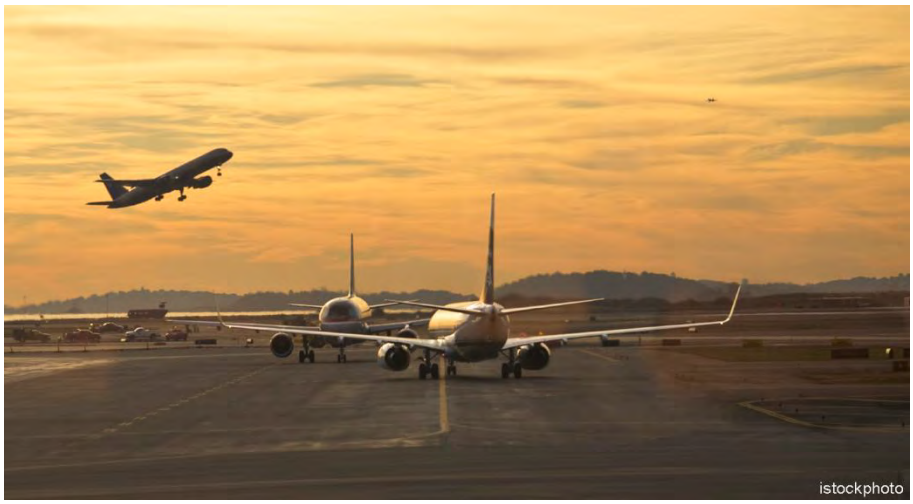

NOTICE


"NextGen is not just capabilities: it is the people who operate those capabilities."
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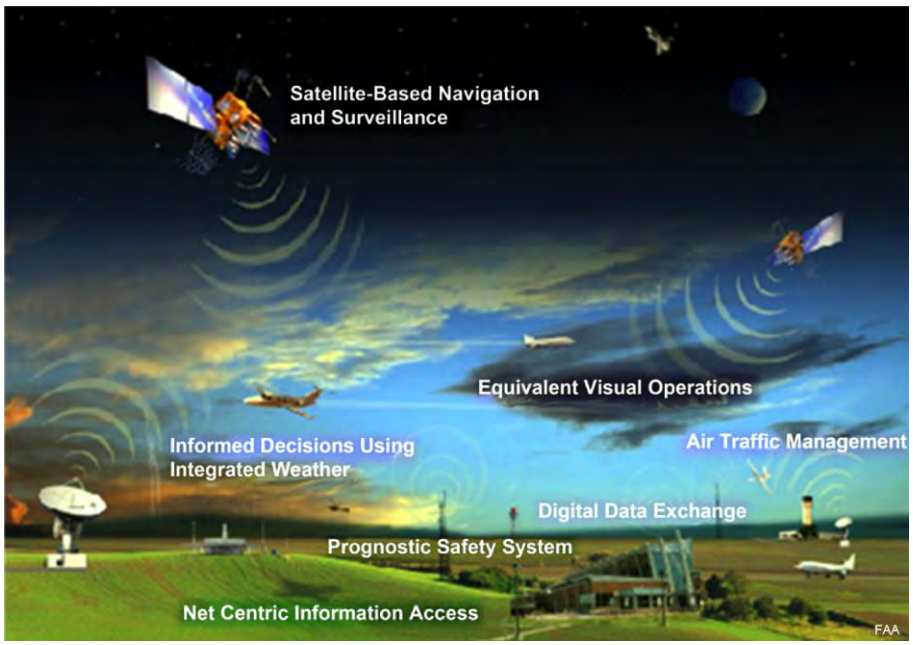
Introduction

The Next Generation Air Transportation System (NextGen) is a comprehensive overhaul of the National Airspace System (NAS) intended to make air travel more convenient and dependable while ensuring that flights are safe, secure, and hassle-free. In a continuous roll-out of improvements and upgrades, the Federal Aviation Administration (FAA) is building the capability to guide and track air traffic more precisely and efficiently to save fuel and reduce noise and pollution. The majority of NextGen's focus has been on new technologies that will improve air traffic management in the NAS. However, NextGen is not just capabilities: it is the people who operate those capabilities.



Future Concepts for NextGen Attempt to Integrate All Aspects of the NAS

In today's operations poor situation awareness and a lack of efficient information tools, such as integrated traffic, weather, and airspace resource information, results in traffic managers reacting to disruptions instead of operating under proactive planning. Coordination between facilities is made difficult when not all facilities are aware of the state of departure routes, or when some do not understand the operational concerns or airspace constraints within another facility's boundaries. For example, an Air Route Traffic Control Center (ARTCC) traffic manager reacts to convective weather or traffic congestion by requiring towers to call for permission to depart flights on certain routes. This constrains the actions the traffic managers at Terminal Radar Control (TRACON) facilities can take to implement Traffic Management Initiatives (TMI) that affect the airports within TRACON airspace. To alleviate surface congestion from the subsequent delays to departures, the Tower traffic manager may request a suspension of arrival traffic. These decisions can cause unintended disruptions to the NAS, delaying flights. This document introduces a concept for the realignment of roles and responsibilities along with integrated support tools that may assist traffic managers in achieving increased collaboration and appropriate decision making among individuals and facilities.

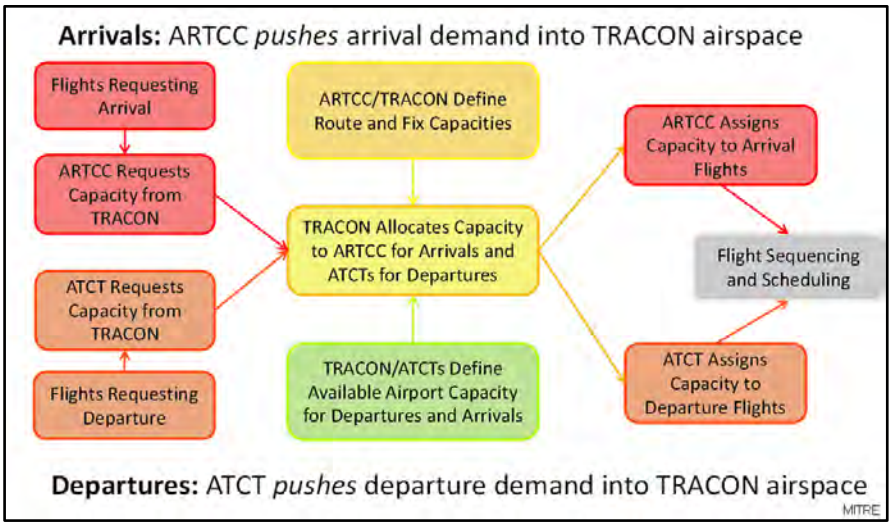
The High Density Area Departure/Arrival Management (HDDAM) concept is being examined as a Mission-Oriented Investigation and Experimentation (MOIE) at The MITRE Corporation's Center for Advanced Aviation System Development (MITRE/CAASD). The HDDAM concept applies a basic principle from management science: Decisions should be assigned to those who are already performing other tasks with the relevant data—and therefore know the most about the factors affecting the decision—and will be most directly affected by the consequences of those decisions. The HDDAM concept realigns the focus of decision making and actions between the ARTCC, TRACON, and Tower into roles and responsibilities that may encourage proactive planning and decision making within the NAS.

THE PROPOSED HDDAM CONCEPT

The HDDAM concept aims to help ensure safe, efficient, and stable arrival and departure traffic management in the presence of weather and other events, by moving the locus of control to the most effective decision maker. The HDDAM concept incorporates automation and shared situation displays to assist all facilities in planning and managing traffic during normal and off nominal conditions such as surface and airspace congestion, weather, and circumstances that may limit airport or airspace capacity.

The HDDAM concept proposes a realignment of the roles and responsibilities between traffic managers in each facility. For departures, the ARTCC will be responsible for determining the capacity across all fixes, the TRACON will allocate capacity slots to each airport to satisfy the capacity set by the ARTCC and the needs of its own airspace, and the Tower will assign the appropriate flights to each time slot. This slot allocation is expected to allow each facility to manage and control the traffic that directly impacts their airspace.

Arrival traffic will be managed similarly to the departure traffic. Each Tower will be responsible for setting the capacity of the airport in terms of the number of flights that can be accepted during a set time frame, the TRACON will allocate arrival slots for each of the arrival routes, and the ARTCC will assign flights to the available arrival routes.



The HDDAM Concept of Operations Allows Each Facility to Manage the Traffic that Directly Affects their Airspace

During severe weather, traffic managers in all facilities are busy managing the air traffic within their airspace or on the ground. This requires extensive coordination and communication between facilities to reduce the impact of the weather on the airspace. These tasks along with other responsibilities increase traffic manager workload. The redistribution of roles and responsibilities among decision makers is expected to reduce traffic manager workload and the amount of communication and coordination required to address changes in the airspace. When all facilities have appropriately shared capacity and constraint information on a similar situation display, they can operate with pooled interdependence, each facility making decisions and taking actions with minimal discussion concerning those choices with the other facilities.

Future applications for HDDAM principles may also address interactions among multiple ARTCCs and with the Air Traffic Control System Command Center (ATCSCC).


“The redistribution of roles and responsibilities is expected to make workload consistent with the least amount of communication needed.”
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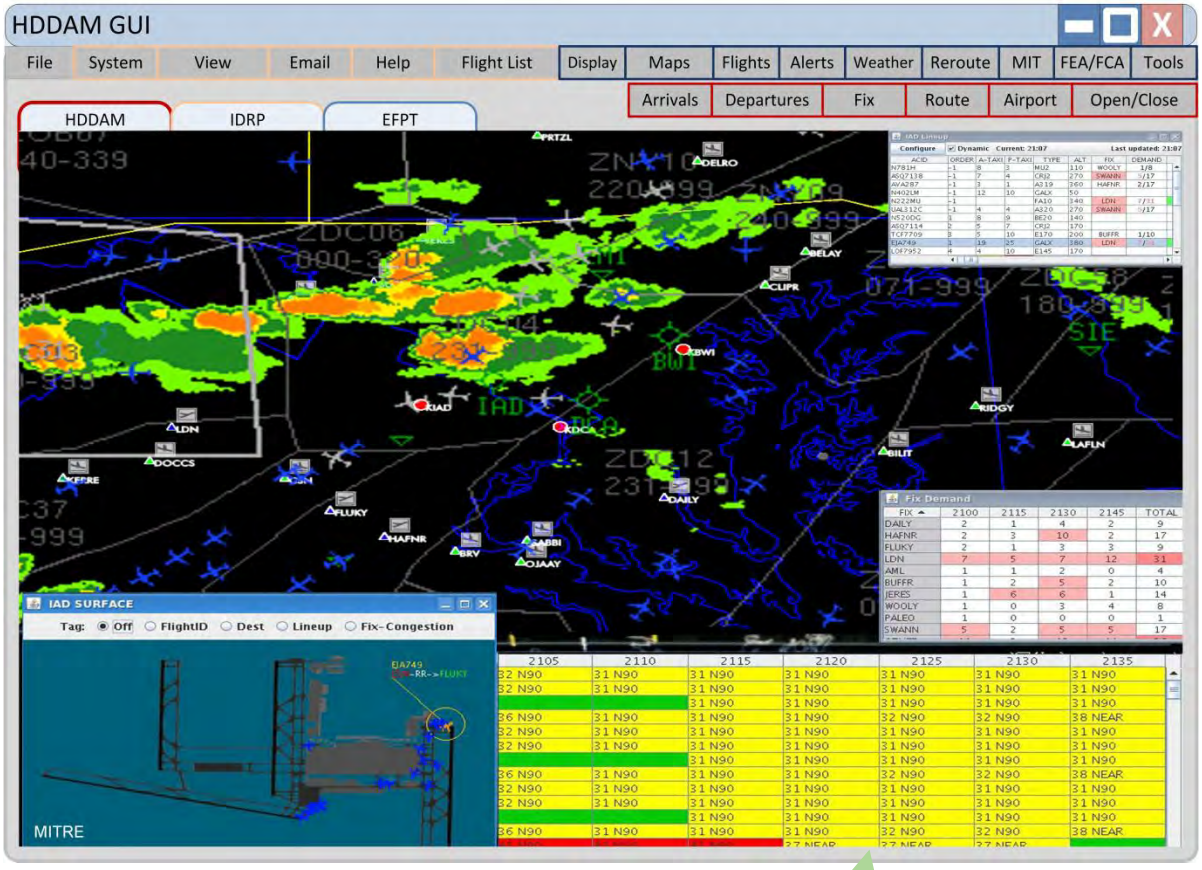


The HDDAM Tool Set is Planned to Integrate Traffic and Weather Information

"Proactive planning will allow the traffic manager to select the appropriate flight for the right fix at the best time."

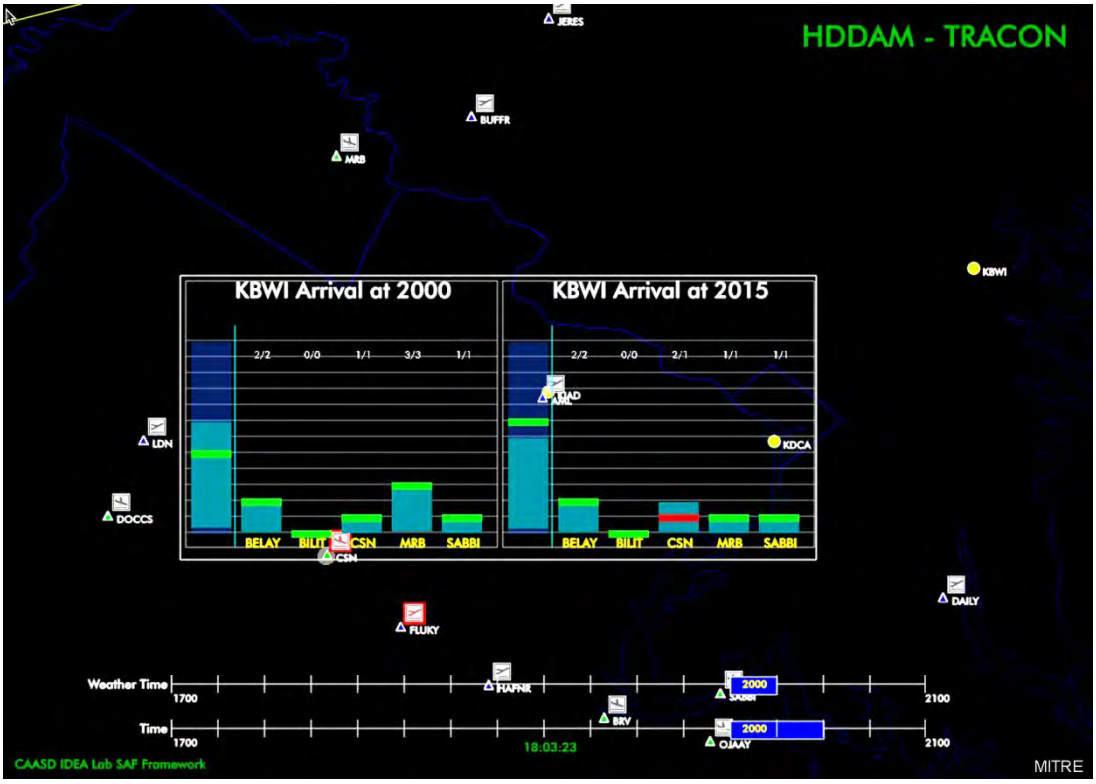
SUPPORT

To help support the exploration of the HDDAM concept it was necessary to provide decision-makers with an interface that provides the information necessary for making the appropriate decisions as outlined in the roles and responsibilities section (pg. 2). The HDDAM Tool Set was created with the intent of providing future traffic managers with an integrated information source incorporating weather, traffic demand, fix capacities, and available route options. This integrated information may allow future traffic managers from each facility to coordinate actions and broadcast changes within their airspace.

This tool set was designed to test the HDDAM concept by allowing each facility to manage the traffic that most directly impacts their airspace with minimal coordination between facilities. The HDDAM Tool Set assists users in performing proactive planning to prepare for future events (weather, congestion) by helping the traffic manager to select the appropriate flight—for the right fix—at the best time.

Each change to the system will be networked to broadcast to the surrounding facilities so that all individuals working with related traffic flows will be able to maintain shared situation awareness. This shared view is expected to reduce the amount of verbal communication required to understand the broader context of the situation in the airspace when actions affecting multiple facilities are being considered.

The HDDAM Tool Set is expected to reduce workload by providing the appropriate information for the required decisions. Information such as this should allow future traffic managers to set capacity, predict demand, and balance the two while making the decisions that directly impact their airspace for efficiently coordinated operations.



Screenshot of the Prototype Development for the HDDAM Tool Set

HUMAN-IN-THE-LOOP

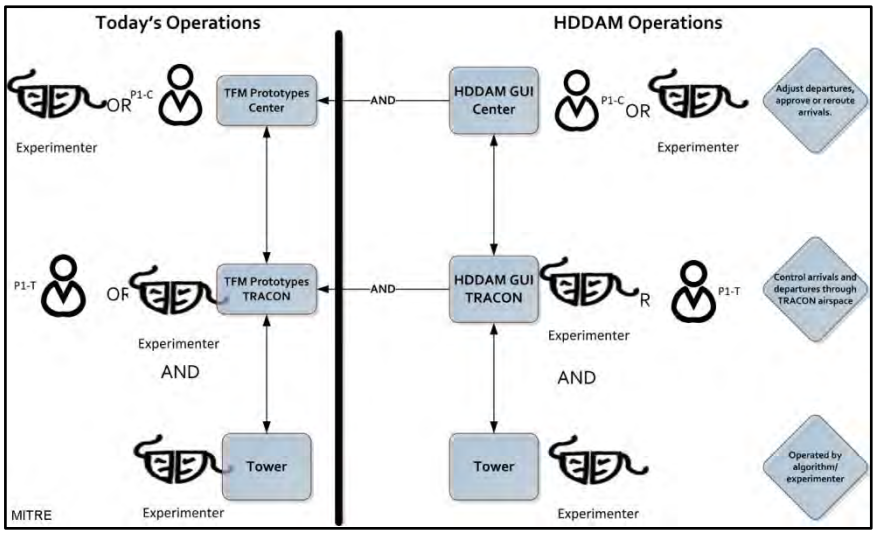
A Human-in-The-Loop (HITL) experiment evaluates concepts and/or software with active participation from human experts. HITL experiments allow participants to interact with realistic models and attempt to perform as they would in real-world scenarios. The experiment is designed to bring to the surface issues that would not otherwise be identified until after a new process is deployed in the field. For these reasons, it is important to seek input from individuals with operational experience to determine how they believe a concept or system should work.

To develop the HDDAM concept, HITL experiments are helping to identify the most efficient allocation of roles and responsibilities among facilities. These experiments are also assisting in refining the information requirements, as well as identifying the operational systems needed to ensure system success.

The 2012 HITL experiment will focus on comparing today's departure and arrival traffic management operations within the Center and the TRACON to how operations will function under the new roles and responsibilities recommended by HDDAM. Participants will be assigned to either the Center (P1-C) or the TRACON (P1-T) and will control traffic flows within the Washington Potomac TRACON airspace.

To emulate today's operations, participants will use Traffic Flow Management (TFM) prototypes to obtain information similar to what is available in today's operations.

HDDAM operations will use the HDDAM Graphic User Interface (GUI) which is integrated with the TFM prototypes.



The 2012 HITL will Compare Today's Operations with the HDDAM Concept Operations (Participants will be asked to manage traffic in either the ARTCC or TRACON role)

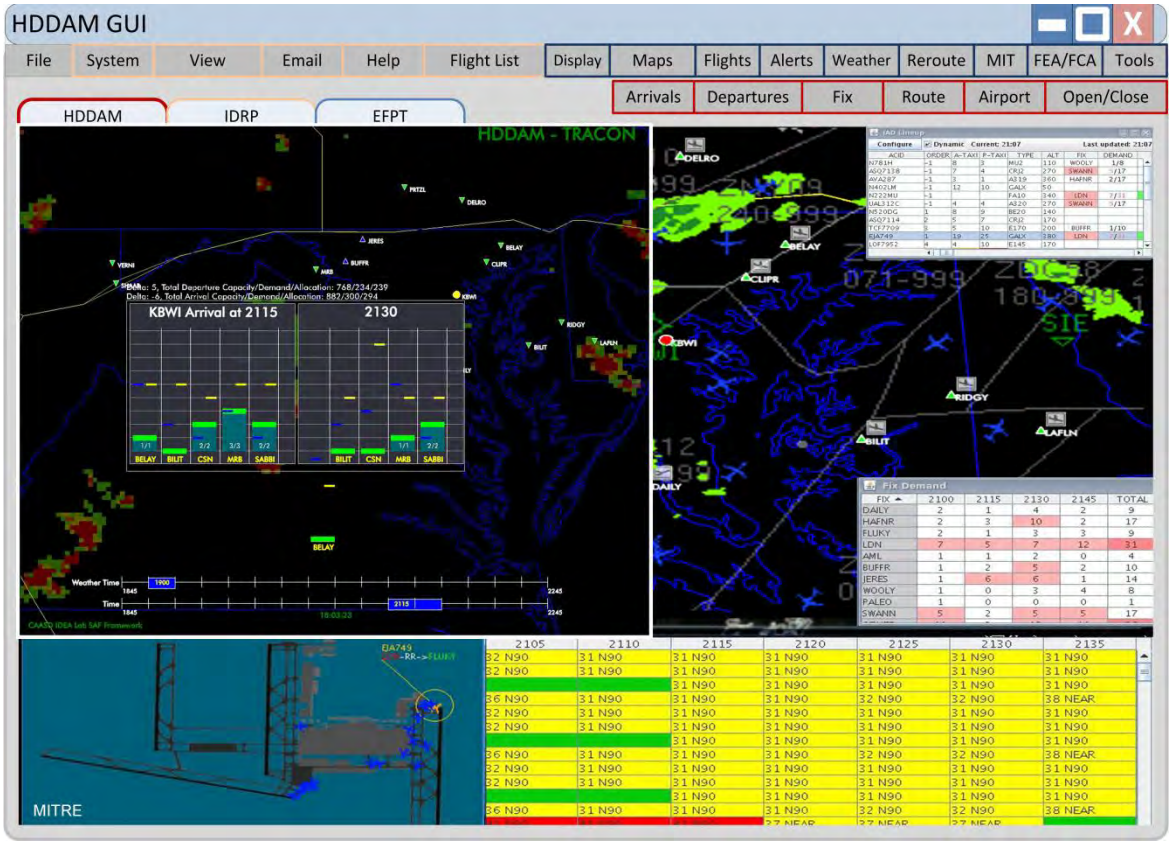
The goal of the HITL experiment is for participants to coordinate changes with surrounding facilities to ensure the greatest flow of traffic through the airspace. A comparison of the two types of operational settings (Today's Operations vs. HDDAM) will help determine whether a realignment of roles and responsibilities will improve efficiency and coordination within the NAS.

Future work on HDDAM may utilize HITL experiments and other research to help identify the best methods of operations and the types of tools required to assist traffic managers in making appropriate decisions based on traffic demand, the state of the airspace, and operational experience.

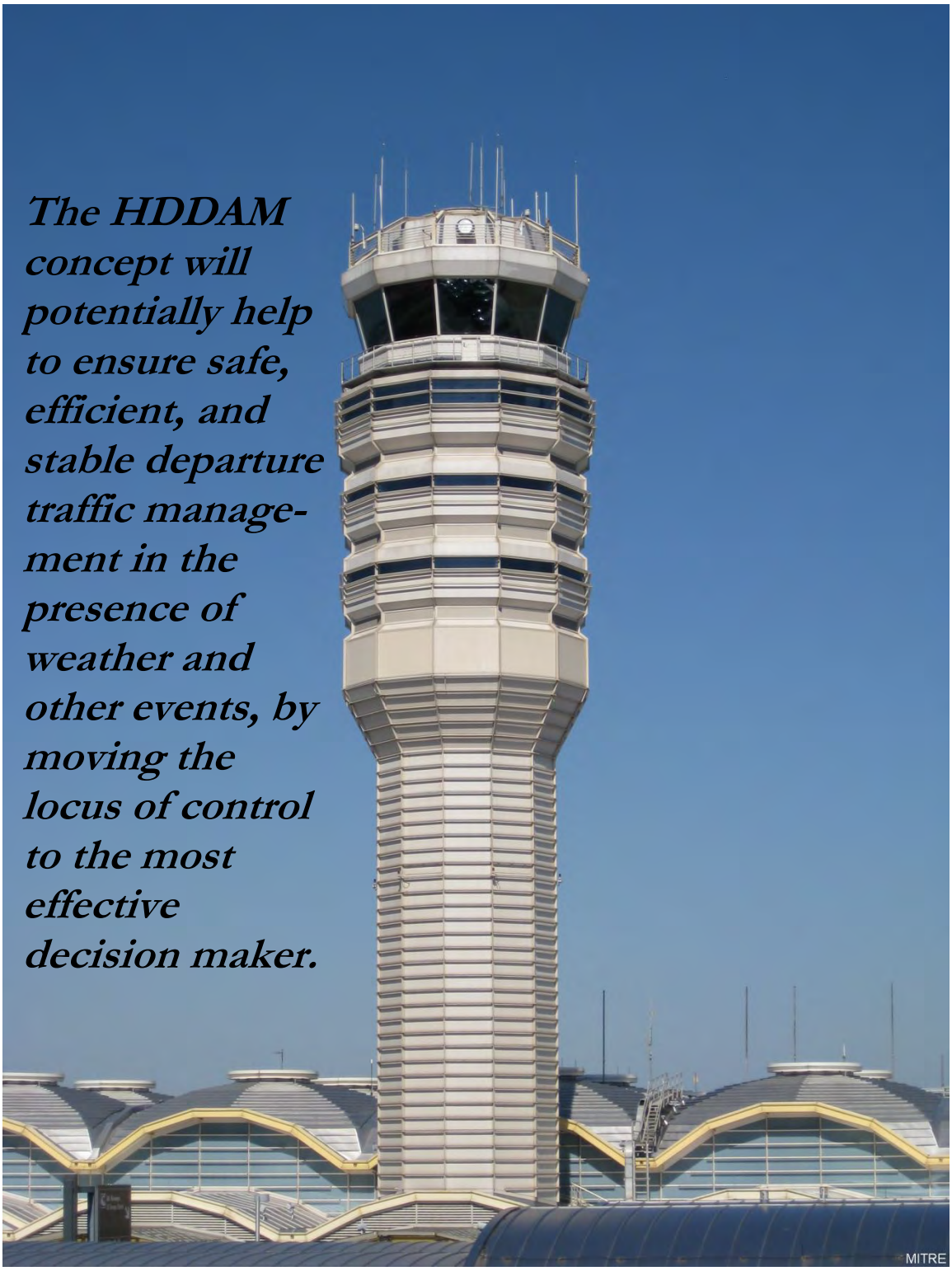
QUOTES FROM 2011 HITL PARTICIPANTS

"Automation that supports distributed decision making and shared situational awareness is beneficial and desperately needed, especially for departures."
—Operational supervisor with experience at ATCSCC, ARTCC, and FAA Program Office

"I think [the HDDAM concept] would place the decision making at the levels where they should be. Coordination of allowable reroutes would need to be worked out and how that would be accomplished."
—ARTCC traffic manager



The HDDAM Tool Set May be Integrated with Other Decision Support Tools for Future HITL Experiments


The HDDAM concept will potentially help to ensure safe, efficient, and stable departure traffic manage-ment in the presence of weather and other events, by moving the locus of control to the most effective decision maker.
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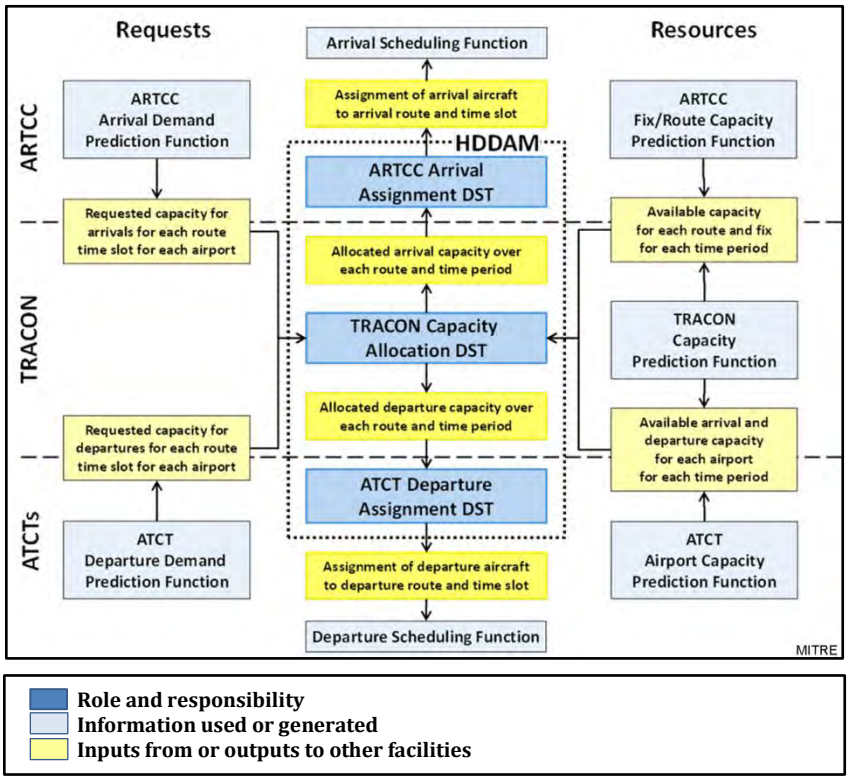
Future

The exploration into the HDDAM concept creates additional opportunities to provide Decision Support Tools (DSTs) for the management of arrival and departure traffic. This may assist the operational personnel in making trade-offs between predicted traffic demand and the resources needed by that demand.

For example, DSTs could help traffic managers decide when and how much to reduce capacity to account for the impact of predicted convective weather. Future tools could gather and analyze data related to setting resource capacity, presenting the decision-makers with options and the range of possible outcomes associated with those options. This would help the traffic managers determine which options are robust with respect to the uncertainties inherent in convective weather forecasts and predicted traffic flows, with a clearer understanding of how their decisions affect the broader air traffic system.

Future HDDAM research will examine the use of HDDAM algorithms in a "what if" mode to analyze options. The resulting decisions on capacity settings would then feed into the HDDAM Tool Set.



The HDDAM Concepts Roles and Responsibilities

Similarly, DSTs could help with sequencing and scheduling flights to meet the time slots assigned to them. For arrivals, these tools might help translate those time slot assignments into appropriate controller actions. For departures, tools could help tower controllers with sequencing and scheduling surface movement so that flights can taxi smoothly from their gates to the appropriate runway with fewer pollution-generating stops and starts. In both cases, the tools could use HDDAM in a "what if" mode to explore the range of typical variability in the system.

As refined models become available for demand prediction, capacity setting, and flight scheduling and sequencing, HDDAM will integrate them through its central role in traffic management decision making.

APPLICATION AND INTEGRATION WITH NEXTGEN

HDDAM principles may also be applied to the interactions among ARTCCs and with the ATCSCC.

To apply HDDAM principles to ARTCC-to-ARTCC interactions, future traffic managers at each ARTCC would be responsible for setting capacities for constrained elements in their airspace, such as specific sectors experiencing congestion or routes impacted by weather. Automation tools could allocate that capacity to underlying airports and neighboring facilities based on predicted demand and delay trade-offs, analogous to the allocations done for departures and arrivals. Flights could then be assigned to the allocated capacity, in coordination with any applicable departure or arrival assignments for those flights. The responsibility for managing flights to meet their assignments will still be with the ARTCC delivering the flights to the constrained facility.

To apply HDDAM principles to ATCSCC interactions, future traffic managers at the ATCSCC would be responsible for setting the NAS-wide framework within which the other facilities operate. For example, the framework would define the trade-offs between airborne delay and ground delay that all facilities will apply. The ATCSCC would also manage relationships with external entities such as air traffic management authorities in other countries. When situations arise that could lead to incompatible actions or conflicting requests, the ATCSCC should be responsible for mediating and prioritizing to achieve solutions that handle demand most efficiently. In addition, the ATCSCC should be responsible for monitoring the overall performance of the NAS—accountable to those who are affected by, but who have no direct role in, air traffic management such as the flying public.

To integrate HDDAM concepts into the NextGen implementation process, it will be necessary to integrate it with planned enhancements such as Tower Flight Data Manager (TFDM), Time-Based Flow Management (TBFM), and other Traffic Flow Management System (TFMS) DSTs.

Screenshot of CDR Fixes Used to Generate Arrival and Departure Data for the HDDAM HITL

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