Airspace Technology Demonstration 3 (ATD-3)

Dynamic Weather Routes (DWR)

Technology Transfer Document Summary

Version 2.0

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Revision History

Rev	Date	Sections Affected	Description of Change	Author
1.0	09/15/2016	All	Original	KSheth EWang
2.0	06/21/2018	2 High-Level Documents	Added NASA TM version of DWR ConOps	EWang

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Introduction

Airspace Technology Demonstration #3 (ATD-3) is part of NASA's Airspace Operations and Safety Program (AOSP) – specifically, its Airspace Technology Demonstrations (ATD) Project. ATD-3 is a multi-year research and development effort which proposes to develop and demonstrate automation technologies and operating concepts that enable air navigation service providers and airspace users to continuously assess weather, winds, traffic, and other information to identify, evaluate, and implement workable opportunities for flight plan route corrections that can result in significant flight time and fuel savings in en route airspace. In order to ensure that the products of this tech-transfer are relevant and useful, NASA has created strong partnerships with the FAA and key industry stakeholders.

This summary document and accompanying technology artifacts satisfy the first of three Research Transition Products (RTPs) defined in the Applied Traffic Flow Management (ATFM) Research Transition Team (RTT) Plan. The original transfer, completed in September 2016, consisted of NASA's legacy Dynamic Weather Routes (DWR) work for efficient routing for en-route weather avoidance. This transfer updates the Concept of Operations document to a publicly-available NASA Technical Memorandum. Blue highlighting indicates the newly modified deliverable.

DWR is a ground-based trajectory automation system that continuously and automatically analyzes active airborne aircraft in en route airspace to identify opportunities for simple corrections to flight plan routes that can save significant flying time, at least five minutes wind-corrected, while avoiding weather and considering traffic conflicts, airspace sector congestion, special use airspace, and FAA routing restrictions.

The key benefit of the DWR concept is to let automation continuously and automatically analyze active flights to find those where simple route corrections can save significant time and fuel. Operators are busy during weather events. It is more effective to let automation find the opportunities for high-value route corrections.

1) Public Outreach Materials

This section contains high-level descriptions and multi-media products appropriate for the general public. Distribution outside of the U.S. Government is permitted without restrictions.

1.01. Dynamic Weather Routes (DWR) Fact Sheet (June 2015)

The DWR factsheet describes the single-flight en-route weather re-routing technology. The factsheet is publicly available on the NASA Ames Aviation System Division webpage (http://www.aviationsystemsdivision.arc.nasa.gov/research/strategic/dwr.shtml).

2) High-Level Documents

This section describes DWR at the Concept of Operations level. Distribution outside of the U.S. Government is permitted without restrictions.

2.01. Dynamic Weather Routes Domestic En Route Concept of Operations Synopsis, Version 1.0 (NASA/TM–2018–219484)

This concept of operations synopsis provides a detailed description of NASA's Dynamic Weather Routes (DWR) concept, its potential benefits, and notional implementation paths.

3) Technical Publications

This section describes DWR at the technology level – including simulation or field trial results, algorithm descriptions, and data analyses. Functional requirements for DWR are based on the ATD-3 technical publications found here. The papers are ordered by date to show the progression. Distribution outside of the U.S. Government is permitted without restrictions.

3.01. Design of Center-TRACON Automation System (HErzberger, AGARD Guidance and Control Panel, Symposium on Machine Intelligence in Air-Traffic Management, Berlin, Germany, May 1993)

3.02. Design of a Conflict Detection Algorithm for the Center/TRACON Automation System (DIsaacson, DASC1997, Irvine CA, October 1997)

3.03. Field Test Evaluation of the CTAS Conflict Prediction and Trial Planning Capability (DMcNally, GNC1998, Boston MA, August 1998)

3.04. Direct-To Tool for En Route Controllers (HErzberger, IEEE Workshop on Advanced Technologies and their Impact on Air Traffic Management in the 21st Century, Capri, Italy, September 1999)

3.05. FACET: Future ATM Concepts Evaluation Tool (KBilimoria, Air Traffic Control Quarterly, Vol. 9, No. 1, pp. 1-20, January 2001)

3.06. Operational Evaluation of the Direct-To Controller Tool (DMcNally, ATM2001, Santa Fe NM, December 2001)

3.07 Weather Forecasting Accuracy for FAA Traffic Flow Management (National Research Council Workshop Report, The National Academies Press, Washington DC, 2003)

The copyrighted book can be accessed via the following link: http://www.nap.edu/catalog/10637/weather-forecasting-accuracy-for-faa-traffic-flow-management-a-workshop

3.08. Description of the Corridor Integrated Weather System (CIWS) Weather Products (DKlingle-Wilson, Project Report ATC-317, MIT Lincoln Laboratory, Lexington MA, August 2005)

3.09. An Exploratory Study of Modeling Enroute Pilot Convective Storm Flight Deviation Behavior (RDeLaura, Aviation, Range, and Aerospace Meteorology (ARAM), Atlanta GA, May 2006)

3.10. An Approach to Verify a Model for Translating Convective Weather Information to Air Traffic Management Impact (WChan, ATIO2007, Belfast, Northern Ireland, September 2007)

3.11. Design of a Research Platform for En Route Conflict Detection and Resolution (JMurphy, ATIO2007, Belfast, Northern Ireland, September 2007)

3.12 Your Flight Has Been Delayed Again, Flight Delays Cost Passengers, Airlines, and the US Economy Billions (A Report by the Joint Economic Committee Majority Staff, Charles Schumer, Carolyn B. Maloney, May 2008)

3.13. Analysis of Automated Aircraft Conflict Resolution and Weather Avoidance (JLove, ATIO2009, Hilton Head SC, September 2009)

3.14. Assessment and Interpretation of En Route Weather Avoidance Fields from the Convective Weather Avoidance (MMatthews, ATIO2010, Fort Worth TX, September 2010)

3.15. Automated Conflict Resolution, Arrival Management and Weather Avoidance for ATM (HErzberger, ICAS2010, Nice, France, September 2010)

3.16. Dynamic Weather Routes: A Weather Avoidance System for Near-Term Trajectory-Based Operations (DMcNally, ICAS2012, Brisbane, Australia, September 2012)

This paper describes the performance and shortfall analysis for multiple metrics: potential flying time savings using proposed re-routes, number of auxiliary waypoints required for weather and traffic avoidance, and reduction in the time (minutes saved) that a sector is over capacity.

3.17. Consideration of Strategic Airspace Constraints for Dynamic Weather Routes (KSheth, ATIO2012, Indianapolis IN, September 2012)

This paper focuses on performance and shortfall analysis of two airspace constraints: predicted downstream sector congestion and active Special Use Airspace (SUA) traversal.

3.18. Operational Evaluation of Dynamic Weather Routes at American Airlines (DMcNally, ATM2013, Chicago IL, June 2013)

This paper examines the DWR system performance during the AA evaluation by comparing the number of routes evaluated, accepted, and rejected by users along with the potential time savings. Another metric addressed is user acceptability of the proposed re-routes. Shortfall analysis is also included.

3.19. Automated Separation Assurance with Weather and Uncertainty (TLauderdale, EIWAC2013, Tokyo, Japan, February 2013)

3.20 Benefits Analysis of Multi-Center Dynamic Weather Routes (KSheth, ATIO2014, Atlanta GA, June 2014)

3.21 Integration of Dynamic Weather Routes Automation with Air/Ground Data Communications (DMcNally, ICNS2015, Washington DC, April 2015)

3.22. Dynamic Weather Routes: Two Years of Operational Testing at American Airlines (DMcNally, ATM2015, Lisbon, Portugal, June 2015)

3.23. Assessment of a National Airspace System Airborne Rerouting Tool (KSheth, ATM2015, Lisbon, Portugal, June 2015)

4) Dynamic Weather Routes Technology Documents

This section contains the DWR functional requirements and internal documentation related to development of the DWR prototype implementation. Distribution outside of the U.S. Government is permitted without restrictions.

4.01. Dynamic Weather Routes Functional and Performance Requirements (September 2016)

This document contains the functional and performance requirements for NASA's DWR technology. It defines the system conditions and requirements to allow the capabilities to function properly to produce benefits. It also identifies interfaces and dependencies needed to achieve success criteria.

4.02. Dynamic Weather Routes Software Architecture Overview (May 2014)

This document provides an overview of the Center-TRACON Automation System (CTAS) implementation of the DWR functionality, including the software architecture, live data processing details, internal data flow between software components, and software dependencies.

4.03. DWR User Guide (May 2014)

This document provides an overview of how to use the DWR features.

4.04. DWR Overview Live Data Feeds (June 2014)

This document provides a list of the live data feeds required as input to CTAS and FACET to utilize the DWR capabilities.

4.05. Starting a DWR Live Session Manually (June 2014)
4.06. Starting a DWR Live Session from Scripts (June 2014)
4.07. Starting a DWR Playback Session Manually (June 2014)

These documents describe the various methods to launch the DWR software while connected to the live feeds or from recorded data.

4.08. DWR V3.1 Release Notes (June 2014)

This document provides the release history of the DWR software. Information for each DWR version includes the release date, release description, software version control labels, and software enhancement/bug fix identifiers ("Prs"). The release notes also indicate the operational and support machines at NTX and NASA V&V used for release processing.

4.09. DWR Software V3.1 (June 2014)

This package contains source code and site adaptations for the DWR functionality implemented in CTAS. This software was previously released to Boeing in June 2014. This version of software can be referenced in NASA's software version control system using the following labels:

- CTAS: dwr_v3.1_boeing
- Adaptations (ZAB, ZHU, ZKC, ZME): DWR_V3_20140306_REL
- Adaptation (ZFW): dwr_v3.1_boeing

FACET source code is restricted and must be licensed directly from NASA. Interested parties should contact the ATD-3 Sub-Project Manager.

4.10. DWR Technical Interchange Meeting (TIM) (October 2016)

NASA conducted a one day TIM at FAA HQ to review the tech transfer artifacts, including the DWR ConOps, shortfall analysis and benefits assessment, requirements, results from operational evaluations, software, and implementation documentation.