Airspace Technology Demonstrations (ATD) Project

Airspace Technology Demonstration 3 (ATD-3) Sub-Project: Applied Traffic Flow Management

ATD Industry Day – ATD-3 Overview Brief

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By 2020, ATD-3 will enable increased TFM efficiency and reduced delays, in domestic and oceanic airspace, by delivering advanced integrated air/ground technologies and procedures that use automation to facilitate the execution of tactical reroutes, strategic user-preferred routes, and enhanced airspace capacity.
ATD-3 Objectives

**Domestic:** Reduce impact of weather uncertainty in domestic airspace by developing integrated air/ground automation tools to continuously search for more efficient routes for individual flights and groups of flights, and the means for efficiently sharing route correction options between traffic managers, dispatchers, pilots, and controllers.

**Oceanic:** Increase oceanic trajectory efficiency and capacity by integrating real-time cost-optimal trajectory search algorithms with air/ground tools to establish and maintain reduced separation minima to maximize the time aircraft fly on their preferred trajectories.
What's the Problem?
Weather Uncertainty and Avoidance in Domestic US Airspace

- Convective weather leading cause of delay in US airspace
- Static avoidance routes employ large buffers to forecast weather, not tailored to daily conditions, no automation to monitor or update as conditions change
- Time-based metering, which reduces delay during heavy arrival demand, not usable during weather events
- Even with known, workable, high-value route correction options, coordination workload for FAA traffic managers & controllers, airline dispatchers & pilots usually prohibitive
- Other than weather radar, pilots can't visualize weather and traffic on which dynamic route corrections are based
Domestic Integrated Concept

**DWR/MFCR**
Delay recovery from stale TMIs – automated search for efficient high value common reroutes for individual flights and multiple flights

**PRE-flight route**

**Common reroute**

**TASAR**
Airborne automated continuous searching for efficient reroutes

**DRAW**
Route corrections to maintain metering and avoid weather

**ORC**
Efficient reroutes for meter fix load-balancing

**Ground station**
(FOC or ANSP)

**Domestic Objective**: Reduce impact of weather uncertainty

- Air-ground integration for dynamic reroutes
- Domestic Objective: Reduce impact of weather uncertainty
- Delay recovery from stale TMIs – automated search for efficient high value common reroutes for individual flights and multiple flights
Dynamic Weather Routes (DWR) Concept

Active Center Flight Plan Route

Return Capture Fix

Dynamic Weather Route

Auxiliary Waypoints

Continuous Automatic Real-Time Search Finds High-Value Route Correction Opportunities for Airborne Flights in En Route Airspace

Maneuver Start Point
DWR User Interface

Potential Savings: 20 min

A320 PHL/LAS
DWR Trials at American Airlines

NASA DWR Automation
↓
Airline ATC Coordinator
↓
Airline Dispatcher
↓
Pilot
↓
FAA Controller
↓
Route Clearance

DWR Display

Dispatcher Use and Estimated Actual Savings
January 2013 to September 2014

- Advised by DWR: 62,899 min (8,993 flights)
- Evaluated by Users: 14,255 min (2,011 flights)
- Accepted by Users: 8,866 min (1,311 flights)
- Rejected by Users: 1,127 min (145 flights)
- Cancelled by Users: 555 flights
- Estimated Actual Savings: 3,290 min (526 flights)
Multi-Flight Common Route (MFCR)

Problem
Weather changes as flights progress, avoidance routes become stale

Solution
Continuous automatic search finds common, high value, ATC acceptable route corrections for multiple flights, MFCR preferred by ATC users

Metrics
- Flight time and fuel savings
- ATC acceptability
- Reduced operator workload
Dynamic Reroutes for Arrivals in Weather (DRAW)

Current scheduled times of arrival do not reflect the need to deviate for weather.

Adjusted times of arrival and metering impact.
Optimized Route Capability (ORC)

• Capability
  – Intelligent off-loading of over-loaded meter fixes
  – Data-driven processes to predict when capacity limits will be exceeded
  – Identify minimal-cost routing options to mitigate projected delay

• Benefits
  – Enable more efficient routing decisions to be made, and to be implemented earlier
  – Increase arrival throughput by utilizing available capacity at alternate meter fixes
  – Reduce delay and fuel consumption by minimizing the need for holding and tactical maneuvering (i.e., vectoring)
  – Augment today’s metering capability and utilization of PBN routing and Optimal Profile Descents by creating synergy between en-route and terminal TFM

Without intervention, demand exceeds capacity at NW arrival gate and results in holding

1. ORC identifies excess demand
2. ORC alerts TMC/STMC
3. ORC identifies candidate reroute
4. TMC/STMC accepts solution
Cockpit Automation for optimizing an aircraft’s trajectory en route that leverages Networked Connectivity to real-time operational data to produce a greatly Enhanced User Request Process for users and service providers.
Traffic Aware Planner (TAP) Software Application

Consumer of Cockpit Connectivity

Connects to avionics via standard interfaces
Ownship flight data, ADS-B traffic data

Optional connectivity to external data sources
Latest winds, weather, airspace status, etc.

Computes real-time route optimizations

- Integrates optimization with conflict avoidance (traffic, weather, airspace)
- Produces lateral, vertical, and combo solutions
  - Powerful pattern-based genetic algorithm
  - Processes 400-800 candidates every minute
- Computes time/fuel outcomes
- Displays solutions and outcomes to the pilots for selection and ATC request

Analyzes pilot-entered route changes

- Touch-screen interface for easy entry
- Displays time/fuel outcomes
- Depicts conflicts with traffic, weather, airspace
Oceanic Objective: Increase oceanic trajectory efficiency and capacity
• Departure plans computed once a day in each direction, may be restricted to rigid route structure due to limited oceanic CNS capability and limited information sharing between users and ANSPs.
  – Not wind-optimal, and no tactical improvements available
  – No accounting for airspace-use charges and other information
• Airlines have capability to compute routes minimizing DOC; However, there is no continuous monitoring ability or situation awareness
• Large separation standards in oceanic airspace (currently 30-120nmi) limit an aircraft’s ability to fly optimal trajectories (altitude and speed) resulting in increased fuel burn
  – Unable to climb due to conflicting traffic
  – Suboptimal speeds due to same route, co-altitude traffic
Dynamic Cost-Optimal Routes

• Capability
  – Pre-Departure Planning of Routes (PDPR)
    Cost-optimal routes minimizing fuel, time and airspace costs and comparative analysis of fuel savings
  – Dynamic Planning of Re-routes (DPR)
    Continuous automated monitoring of en route flights against changes in wind, weather and congestion, provides reroute advisories

• Benefits
  - Flexible, more efficient, automated route planning and benefits information, with situation awareness, for AOC
  - Automated dynamic searches for efficient re-routes based on most current en route information
  - Average savings of 4%, varying from 2% to 6% depending on city-pairs and seasons
  - Actual savings from 1300 lb to 3000 lb of fuel depending on type of aircraft and city-pair
PTM Concept Overview

- **Operational Objective:** Use airborne surveillance and tools to manage reduced “at or greater than” inter-aircraft spacing of ATC assigned aircraft pairs that results in reduced fuel burns and delays

- **Mechanism:** Advanced Interval Management (A-IM) PTM equipment and procedures enable reduced oceanic spacing distances which will allow more aircraft to fly at their preferred altitudes for greater periods of time; providing additional capacity where aircraft desire to operate

**Sample scenarios**

- **Same Route, Altitude Change**
- **Intersecting Routes**

**Characteristics**

- Significant air/ground coordination
- Unique enabling capabilities include:
  - Coincident & non-coincident routes
  - Up to 8 targets which can be ahead or behind the PTM aircraft and can be at a different altitudes
- Significant operational flexibility
PTM Concept Overview (cont’d)

- PTM enables a new separation standard for ATC
  - Uses ADS-B In Surveillance
  - Delegated airborne separation application
- Flight crews do not request a PTM operation. Rather, ATC issues a PTM clearance to resolve potential conflicts
- Crews are given speed guidance and situation awareness necessary to manage their spacing relative to proximate aircraft
- When conventional separation is available, the controller can terminate the PTM operation and reassumes separation responsibility
- PTM Requirements
  - Datacom (e.g., CPDLC) and therefore likely FANS 1/A
  - ADS-B In equipage
    - Similar to FIM equipment (traffic processor, CDTI, forward display)
    - Bundles with other ADS-B in applications to aide business case
- Does not require ATC monitoring for intervention under normal operation
ATD-3 Stakeholder Engagement and Partnership Opportunities

• Concept Development and Maturation
  – Performance evaluations, requirements, and procedure development
  – Utilization of DataComm and secure web-based connections

• Air/Ground Integration
  – Evaluation of ATD-3 tools operating on flight deck and within dispatch (Airlines)
  – Supporting partner airlines with hardware & adaptation (Avionics Mfrs)
  – Integrating user systems with NASA tools (Operations Mgmt)
  – Data products enhancing NASA tools (Information Services)

• Licensing and Commercialization
  – Adapting NASA technology to new stakeholders
  – Integrating with existing products and services
  – Inserting value-added capabilities to enhance commercial potential