Airspace Operations and Safety Program (AOSP)
Airspace Technology Demonstrations (ATD) Project

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Airspace Technology Demonstrations (ATD) Project
ATD Domains

ATD-1
Terminal Sequencing and Spacing (TSAS) and Flight deck Interval Management (FIM)

ATD-2
Integrated Metroplex Traffic Management

ATD-3
Applied TFM
Airspace Technology Demonstration 1

Terminal Sequencing And Spacing (TSAS)
with
Flight deck Interval Management (FIM)
Operational Scenario

Time-based scheduling provides runway arrival times and fix crossing times for arriving aircraft.

En route speed and path assignments correctly space aircraft for descents on RNAV/RNP OPDs to assigned runways.

Aircraft are delivered to meter fixes according to schedule, but with small spacing errors that need to be reduced to maximize throughput and avoid spacing violations.

Most flight crews use FMS to fly OPDs along RNAV/RNP routes – largely without controller intervention.

Some flight crews use onboard speed guidance to achieve and maintain precise traffic spacing.

Terminal controllers correct residual spacing errors and cope with disturbances and off-nominal events using tools and display enhancements based on 4-D trajectories.
Integrated Arrvial/Departure/Surface Metroplex Management
Operational Concept Graphic (OV-1)

Airspace Components
- ARTCC
  - Integrate TBFM/IDAC with ATD-2 surface system
  - Improve TBFM departure trajectory predictions
- TRACON
  - Departures into overhead and metered arrival streams
- Local TMIs and demand predictions for all airports
- Metroplex coordination and planning functions
- Explore departure controller advisory requirements

Surface Components
- Ramp Control
  - Tactical pushback advisories build on SARDA research
  - Manage ramp traffic and meet strategic TMATs
  - Ramp and gate status and intent information
- Surface CDM
  - Builds on Surface CDM concept engineering effort
  - Identify need to meter and compute ration-by-schedule strategic TMATs
  - Accommodate airline priorities
- ATCT Control
  - TFDM EFD is controller interface to ATD-2 scheduling and metering
  - Better predictability improves TMI compliance
- ATCT TMU
  - Tactical departure scheduling builds on IDAC and PDRC
  - Manage traffic to satisfy TMIs and departure metering
- Airport Ops
  - Earliest off block times
  - Airline priorities via CDM
  - Flight data
- Airline Ops
  - Strategic TMIs
  - Surface delays
  - Multi-center coordination
- Industry Apps
  - Information exchange with commercial applications
- Surface CDM
  - External interfaces via SWIM and SWIM extensions
- Airline Ops
  - Airport conditions
  - Additional flight operators
- Airline Apps
  - Strategic TMIs
  - Surface delays
  - Multi-center coordination
- ATCSCC
  - Information exchange with commercial applications
- TRACON
  - Local TMIs and demand predictions for all airports
  - Metroplex coordination and planning functions
  - Explore departure controller advisory requirements
Airspace Technology Demonstration 3

Applied Traffic Flow Management
Freeze Horizon
Pre-flight route
Air-ground integration for dynamic reroutes

MFCR
Delay recovery from stale TMLs – automated search for efficient high value common reroutes for multiple flights

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

Dep

Dest

Ground station
(FOC or ANSP)
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 Re-routes 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.
Traffic Aware Strategic Aircrew Request (TASAR)

Pilot uses onboard automation tool to optimize an aircraft’s trajectory

- **Navigation Database**
- **Aircraft Performance**
- **Pilot Interface**
- **Optimization Engine**
- **Real-time Aircraft Data**

**NASA Technology**

**Operational Outcomes**

- **Crew Request**
- **ATC Response**

- **Increased ATC approval of requests**

**Tool leverages networked connectivity to real-time operational data**

- **Traffic**
- **Weather**
- **Airspace**
- **Dispatch**

- **Internally sourced data**
- **Externally sourced data**

**Greater flight efficiency en route**
Technologies for Airplane State Awareness
Technologies for Airplane State Awareness (TASA)

- CAST’s Airplane State Awareness Joint Safety Implementation Team (ASA JSIT) Recommended Research Safety Enhancements (SEs)
- NASA’s precursor safety focus to *Increase Pilots’ Ability To Avoid, Detect, And Recover From Adverse Events That Could Otherwise Result In Accidents/Incidents*

**Cause and Effect**  →  **Safety Enhancements**
TASA: Safety Enhancements (SE)

Flight Deck Tools

- 200 Design Virtual-Day VMC Displays
- 207 Attitude and Energy State Awareness
- 208 Airplane Systems Awareness

Training Models, Data and Tools

- 209 Research Simulator Fidelity
- 210 Flight Crew Performance Data
- 211 Training for Attention Management
Concluding Remarks

• NASA has developed several foundational technologies in preparation for demonstrations

• These tools leverage the FAA and Industry investments in NextGen infrastructure: ADS-B, RNAV/RNP routes, OPD procedures, Surface Collaborative Decision Making (S-CDM), and Electronic Flight Data

• These technologies demonstrate the benefits of a critical set of NextGen capabilities for future trajectory based operations
Thank you
Operational Improvement

During high-fidelity human-in-the-loop simulations, terminal controllers have been able to maintain consistent use of PBN procedures during busy traffic periods without increased workload by using TSS.
Field Demonstration Strategy

Engineers assess readiness for shadow evaluation by operators

Operators assess readiness for operational evaluation & use

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Commitments to FAA
- Sep 2016: ATD-2 system installation at CLT
- Sep 2017: ATD-2 demonstration commences
- Sep 2018: interim technology transfer
- Sep 2019: interim technology transfer
- Sep 2020: final technology transfer

Chart Legend:
- Development
- Field Activity
- Tech Transfer

ATD-2 High Level Schedule – For NASA Internal Use

- FY16
- FY17
- FY18
- FY19
- FY20

11/4/15

Phase 1: Baseline IADS
Phase 2: Fused IADS
Phase 3: Metroplex IADS
Optimized Route Capability (ORC)

**Capability**
- Intelligent off-loading of over-loaded meter fixes
- Data-driven processes to predict when capacity limits will be exceeded
- Ability to identify optimal path routing options to balance capacity

**Benefits**
- Improving overall system efficiency by utilizing data-driven traffic flow management decisions to optimize route configurations
- Reducing delay and fuel consumption by minimizing the need for holding and tactical maneuvering (i.e., vectoring)
- Enhanced utilization of Performance-Based Navigation (PBN) routing and other NextGen capabilities
- Augments today’s metering capabilities

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