Airspace Technology Demonstration 2 (ATD-2)

Latest IADS Capabilities

Shivanjli Sharma, Bob Staudenmeier, and Lindsay Stevens

March 14, 2018
Remote Demo Series – Schedule

- ATD-2 101 (General Briefing and Demo) May 5th 11AM–1PM EST
- ATD-2 101 (General Briefing and Demo) June 9th 11AM–1PM EST
- ATD-2 201 (Surface/TFBM Scheduling) July 20th 10–11:30 AM EST
- ATD-2 101 (General Briefing and Demo) Aug 3rd 10–Noon EST
- ATD-2 201 (Surface ON time predictions, Runway assignments) Aug 24th 10:30–Noon EST
- ATD-2 301 (Fuser, SWIM Processing & Mediation, Matching) Sept 7th 10:30–Noon EST
- ATD-2 201 (Tactical Surface Metering) Sept 21st 10:30–Noon EST
- ATD-2 201 (Ramp Traffic Tools, Capabilities, Best Practices) Oct 12th 10:30–Noon EST
- ATD-2 101 (General Briefing, Field ”go-live” status update) Nov 9th 10:30–Noon EST
- ATD-2 201 (Real-time Dashboard, Post Ops, Current Reports, Data Analysis) Dec 14th 10:30–Noon EST

- ATD-2 201 (Latest IADS Capabilities) March 14th 11am–Noon EST
- ATD-2 201 (Surface Metering - Initial Analysis, Impact, and Evolution) March 21st 11am–Noon EST

- What would like to see here? Send input to Al.Capps@nasa.gov
ATD-2 Remote Demo Objectives

• Keep broad group of ATD-2 stakeholders informed of progress in an inexpensive and unobtrusive manner

• Demonstrate actual system capability and lessons learned (as opposed to documents/plans)

• Take input from stakeholders that can be used to improve the ATD-2 system, processes and/or outreach

• Identify areas where more detailed discussion is desired/warranted
Go to [https://www.aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2_remote_demos.shtml](https://www.aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2_remote_demos.shtml) to learn about upcoming ATD-2 remote demos!

### ATD-2 Remote Demos

**To Join…**

1. Go to: [https://ac.arc.nasa.gov/atd2/](https://ac.arc.nasa.gov/atd2/)
   Enter as a guest and type your name. NASA Employees can log-in with their email and password (NDC Credentials).

2. Dial the Telecon Number: **1-844-467-6272**, Passcode: **592382#**

### Demo Objectives

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### Schedule

| ATD-2 201 (Tactical Surface Metering) | Sept. 21st 10:30–Noon ET |
| ATD-2 101 (General Briefing, Field “go-live” status update) | Oct. 26th 10:30–Noon ET |
| ATD-2 201 (Real-time Dashboard and Post Ops) | Nov. 9th 10:30–Noon ET |
| ATD-2 201 (Metrics-Baseline, Current Reports, Data Analysis) | Nov. 30th 10:30–Noon ET |
| ATD-2 201 (Understand & Process ATC Restrictions in the NAS) | Dec. 13th 10:30–Noon ET |
Go to https://aviationsystemsdivision.arc.nasa.gov/aosp-partnership-workshop/registration.html to learn about the upcoming AOSP R&D Partnership Workshop!
• The audio and video from this demo are being recorded
Agenda

• Agile Software Development Continuing Into Phase 1

• Baseline IADS System at Phase 1 Go Live

• Expanding Data Exchange and Integration

• Evolution of Overhead Stream Insertion and Surface Metering

• Expanding Real Time Tools

• Lessons Learned
Phase I Continued Shadow Sessions

Gathered operational information from each stakeholder group to gain insight into local needs.

Taking this user-based insight, the ATD-2 team develops requirements and solutions.

Field demo partners review and provide feedback regarding the developed solutions for continued iteration and ongoing development.

Agile software developers implement requirements for testing and demonstrating to field demo partners.

Agile Shadow Session Approach
Continued Shadow Sessions into Phase I

Sep 29, 2017
Phase 1 Go Live

Oct 2017

Nov 2017

Feb 2018

April 5, 2018
FRZ2

Phase 1 System in Use in CLT ATCT and AAL Ramp
Continued Shadow Sessions into Phase I

- **Sep 29, 2017**: Phase 1 Go Live
- **Oct 2017**: 
- **Nov 2017**: 
- **Feb 2018**: 
- **April 5, 2018**: FRZ2

**Phase 1 System in Use in CLT ATCT and AAL Ramp**
Continued Shadow Sessions into Phase I

- **Sep 29, 2017**: Phase 1 Go Live
  - Phase 1 System in Use in CLT ATCT and AAL Ramp
  - Review of Initial Data Exchange & Integration Operational Use

- **Oct 2017**

- **Nov 2017**

- **Feb 2018**

- **April 5, 2018**: FRZ2
## Continued Shadow Sessions into Phase I

<table>
<thead>
<tr>
<th>Date</th>
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Continued Shadow Sessions into Phase I

- **Sep 29, 2017**: Phase 1 Go Live
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- **Oct 2017**: Review of Initial Data Exchange & Integration Operational Use

- **Nov 2017**: Initial Electronic Overhead Stream Insertion

- **Feb 2018**:

- **April 5, 2018**: FRZ2
Continued Shadow Sessions into Phase I

Phase 1 Go Live

- Sep 29, 2017
- Oct 2017
- Nov 2017
- Feb 2018

Phase 1 System in Use in CLT ATCT and AAL Ramp

- Review of Initial Data Exchange & Integration Operational Use
- Initial Electronic Overhead Stream Insertion

FRZ2
Continued Shadow Sessions into Phase I

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Phase 2: Fused IADS Demonstration

**Phase 2 Demonstration Goals**
- Evaluate the Fused IADS system capability
- Demonstrate benefits of strategic surface metering during periods of significant demand/capacity imbalance
- Enhance tactical surface metering to improve non movement area predictability and throughput
- Evaluate inclusion of IADS data on EFD
- Expand to demonstrate more scheduling scenarios for Washington and Atlanta Centers

**Airline Ops**
- Interfaces to external systems via SWIM plus ATD-2 SWIM extensions

**Surface Components**
- ATCT Control
  - Phase 1 capability plus:
  - Include IADS info on EFD
- Ramp Control
  - Phase 1 capability plus:
  - Fused scheduler pushback advisories honor strategic TMATs
  - Prescriptive mode: strategic TMATs applied as constraints in fused scheduler
- Surface CDM
  - Phase 1 capability plus:

**Airspace Components**
- ATCT TMU
  - Phase 1 capability plus:
  - Improvements as needed
- ARTCC
  - Phase 1 capability plus:
  - Expand to ZTL TMU
  - Integrate with arrival metering
- TRACON
  - CLT TRACON TMU
  - ATD-2 UI for TMI entry and situational awareness

**Surface Components**

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**Airline Ops**
IADS Phase 1 Capabilities

Real Time Metrics

Overhead Stream Insertion
Washington ARTCC (ZDC)

Surface Predictive Engine
(Updates every 10 seconds)

Surface modeling logic
- Earliest IN time estimate
- Earliest OFF time estimate
- Latest OUT estimate
- Pushback duration model
- Ramp and AAM taxi time
- Trajectory hovering logic

Scheduling Logic:
- Converging runways
- Flight spacing requirements
- Dual use runways
- Runway crossing delays
- Departure fix separation
- Use of flight state

Data Exchange & Integration

ATC TMC Runway Utilization Intent
TRACON controller runway intent
Highly accurate TBFM-deconflicted ON time estimate
TFM SWIM ETAs
TMs. Controlled Take Off Times (CTOT)
Carrier provided EOBTs
Tactical airline intent (ramp controller)
ATD2 System Running in the Field

STBO – Surface Trajectory Based Operations

RTC – Ramp Traffic Console

DASH – Data Analysis and System Health

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What If System
Backend Infrastructure Refinements

• Refinements in ingestion of data from FAA SWIM feeds and the associated mediation logic

• Development of the TTP SWIM Prototype:
  – Created the services specified in the TTP interface containing TFDM Build 1 elements and some Build2 elements (i.e. FlightDataService, Operational Metrics Service, AirportInformation) along with the ability to publish to the destination topic

• Continued calibration of surface metering through improvements to the tactical scheduler algorithm
Matching Data from Many Feeds to a Flight
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• As the IADS system parses in data from a variety of disparate sources, both FAA SWIM feeds and industry feeds, the correlation of these data feeds to a single flight is a challenge
  – Developed a series of flight mediation rules to enable sorting through duplicate and inconsistent sources of data

• To facilitate this matching a Globally Unique Flight Identifier (GUFI) is created for a flight and then as new data emerges it is used to match to either an existing GUFI or is used to create a new GUFI
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![Diagram of GUFI Creation and Update process]
• A series of decision trees are leveraged to generate predictions for:
  – Pushback Duration
  – Taxi speeds for both departures and arrivals
  – Spot
  – Gate

• These predictions are continuously assessed and have been refined
Refinements to Adaptation Detection Polygons

- Detection polygons are leveraged to ensure predictions are updated as an aircraft moves on the surface of the airport.

- These polygons have been updated to reflect operations as well as keep pace with construction activities.
Initial ATC/Operator Data Exchange and Integration

ATC to Operator

- UAL1087 A319 E
  KILNS-EWR
  A2100
  A10 27 18L 1916

- DAL8928 B752 E
  BARMY-EWR
  A2 27 18L 1916

- JBU1118 E190 E
  KILNS-JFK
  A4 27 18L 1916

Operator to ATC

- FDX1935 B752 E
  KILNS-EWR
  E2230
  FDX 18L 916

- SWA210 A319 E
  KILNS-DCA
  A6 18L P1916

- UPS1283 B752 E
  KILNS-PHL
  UPS 18L 1916

Use of EOBTs in Surface Planning

- EOBT prediction, LGTD prediction and actual OUT at:
  - 10m prior. 40.9% more accurate w/17.6% more predictability
  - 15m prior. 27.8% more accurate w/8.7% more predictability
  - 20m prior. 35.1% more accurate w/6.7% more predictability
  - For 25 minutes and greater. EOBTs and LGTDs are equal

Data shown from 12/14/17 to 01/14/18
Integrated new data into an intuitive display for ramp operations
• Ability to indicate a flight as a medical emergency on either the ATC tool or ramp tool

• This information is then conveyed in an intuitive manner on both user interfaces
Additional Data Exchange and Integration Elements

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- This information is then conveyed in an intuitive manner on both user interfaces
The need for users to add a target if the flight was not generated was also identified and incorporated into the system.

This capability is part of a larger effort to address the concept of having the IADS system reflect airframes for situational awareness.
Incorporating ARMT Features in the IADS System

- With ARMT planned to be subsumed into TFDM, several of the capabilities in this tool are being incorporated into the IADS system
  - Working on integrating this data in an intuitive fashion to enable tools to assist with load balancing

Taxi List

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<th>Flight ID</th>
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<th>Dest</th>
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<td>JA5248</td>
<td>00:08:52</td>
<td>KBZY</td>
<td>OMA</td>
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<th>Dep Fld</th>
<th>Dest</th>
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 AMA Time Legend (mins of delay)

  No Delay | Waiting | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180+
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Departure Fix Status Table

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Lessons Learned from the Operational Field Evaluation

• For EOBTs, there are challenging tradeoffs between stability (update frequency) and accuracy. There are many uses of EOBTs, some with competing goals. What are the most important EOBT metrics that Operators can use as a guideline?

• Procedures for handling early display of overhead stream scheduling ("wheels up") can be situational. When delays are large, the procedure may be different than smaller delays.

• The importance of good gate conflict detection can't be overstated. This in turn leads to the need for high quality arrival data, and some manual inputs to keep up with untracked flights.

• Integrating new data into an intuitive display for ramp operations is non-trivial for both software and procedures. The ramp traffic console in operational use at CLT has a number of 'best practices' integrated from these lessons.

• Accentuating the difference between restrictions due to surface congestion versus those due to overhead stream is challenging, but required.

• Associating flights across FAA and Operator systems has revealed areas where flights may not be properly associated. These are largely invisible to current day systems due to segmentation in domains and tools.
Lessons Learned from the Operational Field Evaluation

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IADS Phase 1 Capabilities – Overhead Stream Insertion

Overhead Stream Insertion

Washington ARTCC (ZDC)

CLT ATCT & TRACON

AAL Ramp

Flight Deck

Surface Predictive Engine

Updates every 10 seconds

Surface modeling logic:
- Earliest IN time estimate
- Earliest OFF time estimate
- Latest OUT estimate
- Pushback duration model
- Ramp and AMA taxi time
- Trajectory hovering logic

Scheduling Logic:
- Converging runways
- Flight spacing requirements
- Dual use runways
- Runway crossing delays
- Departure fix separation
- Use of flight state

Real Time Metrics

Surface Metering

Data Exchange & Integration
On November 1st, 2017 IDAC style negotiation with ZDC was introduced
  – CLT ATCT has been actively using STBO to electronically negotiate APREQ
times (86% of all ZDC flights)
  – AAL ramp controllers electronically receive the negotiated time via RTC
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\textbf{STBO at CLT ATCT}
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Additional Electronic Overhead Stream Insertion Capabilities - Swaps

STBO at CLT ATCT

TBFM at ZDC
Additional Electronic Overhead Stream Insertion Capabilities - Flight Exclusions/Inclusions
Additional Electronic Overhead Stream Insertion Capabilities - Flight Exclusions/Inclusions
Additional Electronic Overhead Stream Insertion Capabilities - Single Flight Exclusions

Single flight exclusions from a Ground Stop TMI and Departure Fix Closure TMI available
Added the source for MITs, Ground Stops, and Departure Fix Closures to the TM Actions panel and the Notification Table's Details.
Additional Electronic Overhead Stream Insertion Capabilities – Display of Flights on the Timeline

STBO TimeLine initially displayed flights in the order in which controlled flights were scheduled not necessarily the time they were actually predicted to depart. AAL1946 is clearly ahead of AAL450 in queue. However, this is not reflected on the timeline.
Refined display of flights on the timeline to reflect the best estimate of when a controlled flight will actually depart by updating its actual position on the timeline after it passes the spot.
Lessons Learned from the Operational Field Evaluation

• Showing available overhead stream capacity ("red space, green space") to surface planners in an integrated and intuitive manner can reduce delay.

• Look-ahead scheduling time horizon calibration is a challenging tradeoff between scheduling too early with uncertain data that can lead to re-planning, versus too late with predictive certainty but lower benefits to all.

• Taxi time calibration is a challenging tradeoff between taxi time predictions that are on the ambitious side with less delay but more re-planning, versus on the late side with less re-planning but more congestion.

• Crawl, walk, run strategy is prudent in this area at large facilities. Starting with electronic negotiation might lead to negative side effects at some facilities if EOBTs and taxi times are not calibrated, with operational procedures in place.

• Target Movement Area entry Times (TMATs) are important hand off point for FAA controlled flights. If surface metering TMATs are held equally important to FAA controlled flight, this effectively de-accentuates their importance.
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• **Showing available overhead stream capacity** ("red space, green space") to surface planners in an integrated and intuitive manner can reduce delay.

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• **Target Movement Area entry Times (TMATs)** are important hand off point for FAA controlled flights. If held equally important to FAA controlled flight, they should reflect their importance.
IADS Phase 1 Capabilities – Surface Metering
Initial Surface Metering Initiation
## Evolution of Surface Metering Initiation

### Surface Metering Display

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<th>Parameter</th>
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<th>New Value</th>
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<th>Parameter</th>
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<tr>
<td>Target Excess Queue Time:</td>
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<td>Lower Threshold:</td>
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### 18L

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Evolution of Surface Metering Initiation – Excess Queue Time

![Surface Metering Display](image)
Evolution of Surface Metering Initiation – Excess Queue Time
Metering by Runway Notification Across Interfaces

RTC

Metering not enabled icons:

Metering enabled icons:

STBO

Metering not enabled icons:

Metering enabled icons:
Lessons Learned from the Operational Field Evaluation

- Finalize the surface metering plan when accuracy is at its best. EOBTs predictive accuracy is currently at its best within 20 minutes prior to push/bank.

- For maximum benefit and flow performance, the ability to front load a bank is important to both departure and arrival flow performance. Otherwise, a ‘slow start’ may ripple through the bank.

- In addition to EOBTs, actual flight pushback/taxi is useful to trigger metering. This gives substantially more control and leads to more consistent taxi out.

- The ‘invisibility’ of EOBTs, metering guidance on ramp displays and communication of guidance to pilots and ground crews require a cultural adjustment.

- Arrival configuration and changes in runway utilization are important for harmonious planning of surface metering with the arrival and departure banks.

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Continuing Effort for Phase I

- Targeted at satisfying Surface and Data Sharing NIWG recommendations
  - “Evaluate the integration of departure metering that reflects the FAA’s Surface CDM ConOps”
  - Reduce risk for TFDM deployment
  - Identify Operator needs to support and benefit from TFDM in an integrated environment
  - Identify likely benefits of Initial TBO using operational field demonstration results

- Moving forward
  - Surface metering expansion to other banks
  - Roll out more advanced features for deeper benefits
  - Expand electronic scheduling to ZTL
  - Share surface data elements via new SWIM feed
  - Continue to work with community on EOBT calibration
What is Next for ATD-2?

Phase 2 (Fusion, Sept 2018)
- Strategic planning tools (strategic/tactical fusion)
- Electronic Flight Data (EFD) Integration
- TFDM Terminal Publication (TTP) prototype
- Mobile app for EOBTs (GA community)
- ZTL/ATL airspace tactical scheduling
- Agile development from:
  - Field demo partner requests
  - TFDM risk reduction needs (as requested)
  - Surface CDM and CAT Team Input (as requested)

Phase 3 (Terminal, Sep 2019)
- Terminal departure airspace constraints
- Additional APREQ features
- Agile development from:
  - Field demo partner requests
  - TFDM risk reduction needs (as requested)
  - Surface CDM and CAT Team input (as requested)
• Questions?
Thank you!