Flight Deck Implications for the Implementation of an Integrated Arrival, Departure, and Surface (IADS) Traffic Management System

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Human-Centered Systems Lab (HCSL) at NASA Ames Research Center
• Airspace Technology Demonstration 2 (ATD-2)

• Integrated Arrival, Departure, and Surface (IADS) traffic management system

Scheduling tools for efficiently managing traffic from the gate to the overhead stream merge.
Scheduling tools for efficiently managing traffic from the gate to the overhead stream merge.

- Airspace Technology Demonstration 2 (ATD-2)
- Integrated Arrival, Departure, and Surface (IADS) traffic management system

**Surface**
Improved predictability on the surface (push, taxi, takeoff times).

**Overhead Stream**
Enables improved demand predictions and more precise scheduling into constrained overhead flows.

**SJSU**
ATD-2 IADS Capabilities

- ATD-2 combines existing and emerging technologies to create the IADS traffic management system

**Departure Scheduling** Produces airspace trajectory predictions to enable more precise scheduling into overhead traffic streams.

**Data Exchange and Integration** Increased sharing of data and decision information among users.

**Surface Modeling** Produces surface trajectory predictions.

**Surface Scheduling** Generates target times and monitors demand and capacity imbalance estimates.

**Surface Metering** Throttles demand to the runway.
ATD-2 IADS Interfaces

• ATD-2 IADS improves predictability through a coordinated schedule between the Ramp, Tower, Terminal, and Center control facilities

**Ramp Tower**
Ramp Traffic Console (RTC): Flight information, pushback advisories

**ATC Tower**
Runway arrival/departure timelines, flight list, map, TMI status

**ARTCC (Center)**
Departures into overhead streams
ATD-2 IADS Flight Deck Implications

- Airspace Technology Demonstration 2 (ATD-2)
- Integrated Arrival, Departure, and Surface (IADS) traffic management system

**Flight Deck**

- Which parts of the ATD-2 IADS system impact the Flight Deck?
- What procedures are required of pilots to support the IADS system?
- What pilot training and communication are needed?
Pilot Engagement and Outreach

- Subject Matter Expert Interviews
- Pilot Community Engagement at CLT
- (3) Pilot Webinar Briefings
- Distribute Pilot-Training Materials
- MITRE's General Aviation User Forum
- Measure Real-World Procedural Compliance

Timeline:
- 2016
- Feb 2017
- April – July 2017
- Sept 2017
- Sept 29th 2017
- Nov 2017
- May 2018

Events:
- ATD-2 IADS Phase 1A Go Live at CLT
- Distribute Pilot-Training Materials

Images:
- Pilot Community Engagement at CLT February 2017
- MITRE's GA User Forum at CLT November 2017
Flight Deck Implications of ATD-2 IADS at CLT

Main Ramp: Commercial Airlines

General Aviation / Business Jet Operations
Flight Deck Departure Procedures

Push –60 min
- Review Planning Documents

Push –30 min
- Retrieve ATIS
- Receive Pre-Departure CLR.
- Retrieve Performance Data
- Configure FMS/MCP
- Final Manifest Gate Agent
- Receive Final Weights
- Verify Fuel
- Close Doors

Push –10 min
- Departure / Takeoff Briefing
- Before Start Checklist

Push –5 min
- Before Pushback Checklist

Pushback
- Call Ramp for Pushback
- Coordinate Push w/ Tug
- Start First Engine

Spot
- Contact Ground Co.
- Enter AMA

Taxi through the Ramp to the Spot
- Start Second Engine
- Final FMS/MCP, Flaps, Stab Trim

- Frequency Change at each Sector
- Contact Controller at each Sector
Flight Deck Departure Procedures

Runway Assignment from Ground Controller at the AMA Entrance

*If Different ...*

Implications for Flight Deck:
- Request new performance numbers via ACARS
- Reprogram FMS
- Verify FMS
- MCP Configuration
- Runway-Change Checklist (some airlines)
- Pilot Strategies:
  - Slow taxi speed
  - Stop aircraft

Expected Runway from Ramp Controller at the Gate (?)
Flight Deck Departure Procedures

Estimated Departure Clearance Time (EDCT)

When to pushback to meet Wheels-Up?

- Duration of taxi?
- Length of Runway Queue? (not visible)
- Request to wait in Hardstand?

Implications for Flight Deck:

*If overestimate taxi duration:
- Extra fuel burn if arrive at Runway early
- Holding near the Runway can impact flow of other traffic

*If underestimate taxi duration:
- Risk missing EDCT if underestimate taxi duration
ATD-2 IADS Data Exchange and Integration

• Share information among all operators who are responsible for managing traffic to support efficient operations.
• Share information among all operators who are responsible for managing traffic to support efficient operations.

Information Sharing (Data Elements) with Flight Deck Implications:

- Runway Assignment
- TMI: EDCT
- TMI: APREQ
- Departure Fix Closures / Airport Closures
- Runway for Operational Necessity
- Gate Advisories for Surface Metering
- Earliest Off-Block Time (EOBT)
Runway Assignment

Prior to ATD-2 IADS
• Runway assignment was typically communicated to pilots by Ground Control at the spot or (sometimes) by Ramp Control.

ATD-2 IADS Information Sharing
• Ramp Control is equipped with runway assignment information.
• *Expected* runway (accurate/reliable) is incorporated into the pushback clearance so pilots know their runway earlier.

Pilots call for Pushback

"Pushback approved, expect Runway 18C."

ATC Tower

Runway Assignment

Ramp Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Flight Deck
Flight Deck Implications of ATD-2 IADS at CLT

TMI: Estimated Departure Clearance Time (EDCT)

Prior to ATD-2 IADS
- Pilots estimated when to pushback to meet EDCT.
- Ramp Control and ATC didn't always have the same EDCT.

ATD-2 IADS Information Sharing
- Ramp Control tools support pushback coordination to meet the EDCT, without excess taxi time.
- Depending on EDCT, scheduler may assign a Gate Hold.

Pilots call for Pushback Time Advisory

"You have an EDCT time of 1430, hold for 20 min."

"Pushback approved, expect Runway 18C."

20 min later ...

PRE-DEPARTURE CLR
EDCT 14:30Z

Flight Deck

Airlines

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Ramp Tower

20 min

AAL705
BOBZYSFO
E1430
C6 9 18C
P10
Flight Deck Implications of ATD-2 IADS at CLT

TMI: "Wheels-Up Time" / "Release Time" (APREQ)

<table>
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<th>Prior to ATD-2 IADS</th>
<th>ATD-2 IADS Information Sharing</th>
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<td>• Pilots were often unaware until contacting Ground Control.</td>
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<td>• Ramp Control was unaware of Wheels-Up times (APREQs).</td>
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<td>• Ramp Control tools support pushback coordination to meet the APREQ (Wheels-Up Time), without excess taxi time.</td>
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<td>• Depending on APREQ, scheduler may assign a Gate Hold.</td>
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*Negotiation of APREQ (overhead slot) *

Flight Deck before Pushback

*Negotiation is not triggered until the Flight Deck contacts Clearance Delivery.*
**TMI: "Wheels-Up Time" / "Release Time" (APREQ) (cont'd.)**

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| • Pilots were often unaware until contacting Ground Control.  
• Ramp Control was unaware of Wheels-Up times (APREQs). | • Ramp Control tools support pushback coordination to meet the APREQ (Wheels-Up Time), without excess taxi time.  
• Depending on APREQ, scheduler may assign a Gate Hold. |

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**ATC Tower**

**ATD-2 IADS Surface Scheduler / Planning Algorithms**

**Pilots call for Pushback Time Advisory**

**Wheels-Up Time (APREQ)**

"You have a Wheels-Up time of 2100, hold for 10 min."

**Ramp Tower**

"Pushback approved, expect Runway 18C."

10 min later ...
## Departure Fix Change/Closure

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<th>• Departure Fix closures were typically communicated to pilots by Ground Control at the spot or (sometimes) by Ramp Control.</th>
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| ATD-2 IADS Information Sharing | • Ramp Control is equipped with Departure Fix status.  
• Ramp Control communicates to pilots when Departure Fixes are closed or combined. |

**ATC Tower**  
ATD-2 IADS Surface Scheduler / Planning Algorithms

**Ramp Tower**  
Pilots call for Pushback

"Contact Clearance Delivery for new route, call when ready for push."
### Flight Deck Implications of ATD-2 IADS at CLT

#### Specify Runway for Operational Necessity

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| • Pilots specified runway need to Ramp Control or Ground Control. | • Pilots specify runway for operational necessity to Ramp Controller while at the gate (as soon as known).  
• Ramp Control electronically communicates need to ATC. |

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**As soon as known:**

"Runway 18C for Operational Necessity"

![Flight Deck](image1.png)  
**Flight Deck**

![Ramp Tower](image2.png)  
**Ramp Tower**

![ATC Tower](image3.png)  
**ATC Tower**

**ATD-2 IADS Surface Scheduler / Planning Algorithms**
## Flight Deck Implications of ATD-2 IADS at CLT

### Pushback Advisories ... when Surface Metering is in Effect

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<td>• Time-based Surface Metering throttles demand to the runway.</td>
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<tr>
<td>• Flights are held at the gate instead of in long departure queues.</td>
</tr>
<tr>
<td>• Shifts excess taxi delay from the taxiway to the gate.</td>
</tr>
<tr>
<td>• Reduced runway queue, reduced fuel burn and emissions.</td>
</tr>
<tr>
<td>• EDCTs and APREQs (Wheels-Up) exempted from Metering.</td>
</tr>
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### ATC Tower

**Pilots call for Pushback**

"Hold 5 min for metering."

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### Ramp Tower

5 min later ...

"Pushback approved, expect Runway 18C."
**Flight Deck with ATD-2 IADS Information Flow**

**Push –60 min**
- Review Planning Documents

**Push –30 min**
- Retrieve ATIS
- Receive Pre-Departure Clr.
- Retrieve Performance Data
- Configure FMS/MCP
- Final Manifest Gate Agent
- Receive Final Weights
- Verify Fuel
- Close Doors

**Push –10 min**
- Departure / Takeoff Briefing
- Before Start Checklist
- **Pilots Specify RWY for Op. Necessity***
- **Ramp Controller: Fix/Airport Closed***

**Push –5 min**
- Before Pushback Checklist
- **Pilots call CD for Wheels-Up Time***
- **Pilots call Ramp for Pushback Adv.***
- **Ramp Controller: Gate Hold Advisory***
  - EDCT
  - Wheels-Up (APREQ)***

*If applicable*
Pilot Outreach and Training

Pilot Communication Distributed Prior to ATD-2 Go Live

- 15 Airlines at CLT's Main Ramp (Mainline and Regional)
- 2 Pilot Organizations (distributed Operational Bulletins)

Overview and Expected Benefits

Pilot Procedures

Wheels-Up Time Flowcharts
Of flights subject to a Wheels-Up Time (APREQ), percent that contacted Clearance Delivery before calling Ramp Control for pushback.

63% Average
February 2018
Real-World Procedural Compliance

PDC Message

PRE-DEPARTURE CLR
CTC CD 127.15
JUST B4
PUSHBACK

- Flight is subject to a Wheels-Up Time
- **Action Required**: Contact Clearance Delivery just before pushback
# Flight Deck Implications of ATD-2 IADS

**Earliest Off-Block Time (EOBT)**

| ATD-2 IADS | • Best prediction of earliest expected pushback/takeoff time.  
|            | • EOBT ('ready-time') are ingested by the Surface Scheduler / planning algorithms. |

**Earliest Off-Block Time (EOBT):**

- Calculated by airlines
- Calculated in real-time
ATD-2 IADS

- Best prediction of earliest expected pushback/takeoff time.
- EOBT ('ready-time') are ingested by the Surface Scheduler / planning algorithms.

Earliest Off-Block Time (EOBT):

- Calculated by airlines
- Calculated in real-time
Flight Deck Implications of ATD-2 IADS at CLT

Main Ramp: Commercial Airlines

General Aviation / Business Jet Operations
General Aviation (GA) Information Sharing

Main Ramp (Commercial)

- **Airlines**
  - **EOBTs**
  - **ATC Tower**
  - **Scheduler / Planning Algorithms**
  - **Ramp**
  - **Flight Deck Commercial at the Main Ramp**

### General Aviation / Business Jet Operations

- **No Airlines to compute and share more accurate EOBTs (ready-times)**
  - **Filed departure time only**
- **No Ramp Controller to exchange information with Pilots**
- **Flight Deck General Aviation Business Jet**

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*Image credits: NASA, SJSU*
General Aviation (GA) Information Sharing

Main Ramp (Commercial)

- EOBTs
- Airlines
- ATC Tower
- Scheduler / Planning Algorithms
- Ramp
- Flight Deck Commercial at the Main Ramp

General Aviation / Business Jet Operations

- Mobile Application for GA Pilots to facilitate information sharing
- ATC Tower
- Scheduler / Planning Algorithms
- Mobile App
- Flight Deck General Aviation Business Jet
ATD-2 IADS Information Sharing

- Mobile App to enable information flow for GA flights.
- Ready-to-Taxi Time (RTT) similar to EOBT at the Main Ramp.
- The MITRE Corporation developing prototype 'Taxi Time' App


ATD-2 IADS Surface Scheduler / Planning Algorithms
General Aviation (GA) Information Sharing

### Mobile App: Two-Way Information Flow

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<td>• Two-way information flow to send information back to pilots.</td>
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<tr>
<td>• Expected beta-testing 2018</td>
</tr>
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<td>• The MITRE Corporation developing prototype 'Taxi Time' App</td>
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**Flight Deck**

General Aviation Business Jet

- **Ready-to-Taxi Time**: 5:00 Z
- **RWY 18L**
  - Takeoff 5:12
  - Wheels-Up
  - Arrival 7:04

**ATD-2 IADS Surface Scheduler / Planning Algorithms**

- Runway Assignment
- Expected Takeoff Time
- Wheels-Up Time Status
- Expected Arrival (Dispatch)
Expanding IADS and the Mobile App

General Aviation / Business Jet Operations

- Larger proportion of GA operations at DAL
- More of an impact in the IADS Scheduler / Planning Algorithms
- Exploring 2019 / 2020 timeframe

Charlotte Douglas (CLT) 6%

Dallas Love Field (DAL) Close to 25%
ATD-2 IADS

- Airspace Technology Demonstration 2 (ATD-2)
- Integrated Arrival, Departure, and Surface (IADS) traffic management system
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