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

Deborah L. Bakowski, M.A.
SJSU at NASA Ames Research Center

Becky L. Hooey, Ph.D.
NASA Ames Research Center

Robert W. Koteskey, M.A.
SJSU at NASA Ames Research Center

David C. Foyle, Ph.D.
NASA Ames Research Center

Human-Centered Systems Lab (HCSL) at NASA Ames Research Center

9th International Conference on Applied Human Factors and Ergonomics (AHFE)
July 21 – 25, 2018
Orlando, FL
ATD-2 IADS

- 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.

Scheduling tools for efficiently managing traffic from the gate to the overhead stream merge.
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
ATD-2 IADS Phase 1A
Go Live at CLT
MITRE’s General Aviation User Forum
Measure Real-World Procedural Compliance

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

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
Charlotte (CLT) Main Ramp
Flight Deck Departure Procedures

Spot
- Contact Ground Co.
- Enter AMA

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

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

Taxi through the Ramp to the Spot
- 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

<table>
<thead>
<tr>
<th>Prior to ATD-2 IADS</th>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Runway assignment was typically communicated to pilots by Ground Control at the spot or (sometimes) by Ramp Control.</td>
<td>• Ramp Control is equipped with runway assignment information. • <em>Expected</em> runway (accurate/reliable) is incorporated into the pushback clearance so pilots know their runway earlier.</td>
</tr>
</tbody>
</table>

---

**Pilots call for Pushback**

"Pushback approved, *expect Runway 18C.*"
## Flight Deck Implications of ATD-2 IADS at CLT

### TMI: Estimated Departure Clearance Time (EDCT)

<table>
<thead>
<tr>
<th>Prior to ATD-2 IADS</th>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
</table>
| • Pilots estimated when to pushback to meet EDCT.  
• Ramp Control and ATC didn't always have the same EDCT. | • Ramp Control tools support pushback coordination to meet the EDCT, without excess taxi time.  
• Depending on EDCT, scheduler may assign a Gate Hold. |

### Flight Deck

**EDCT**

**Airlines**

**ATC Tower**

**Ramp Tower**

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

---

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

"Pushback approved, expect Runway 18C."

20 min later ...
Flight Deck Implications of ATD-2 IADS at CLT

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

| Prior to ATD-2 IADS | • Pilots were often unaware until contacting Ground Control.  
|                     | • Ramp Control was unaware of Wheels-Up times (APREQs). |
| ATD-2 IADS Information Sharing | • 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. |

*Negotiation of APREQ (overhead slot)

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

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

Pilots call for Pushback Time Advisory

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Wheels-Up Time (APREQ)

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

Ramp Tower

10 min later ...

"Pushback approved, expect Runway 18C."
# Flight Deck Implications of ATD-2 IADS at CLT

## Departure Fix Change/Closure

<table>
<thead>
<tr>
<th>Prior to ATD-2 IADS</th>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
</table>
| • Departure Fix closures were typically communicated to pilots by Ground Control at the spot or (sometimes) by Ramp Control. | • 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

<table>
<thead>
<tr>
<th>Prior to ATD-2 IADS</th>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pilots specified runway need to Ramp Control or Ground Control.</td>
<td>• Pilots specify runway for operational necessity to Ramp Controller while at the gate (as soon as known).</td>
</tr>
<tr>
<td></td>
<td>• Ramp Control electronically communicates need to ATC.</td>
</tr>
</tbody>
</table>

**As soon as known:**

"Runway 18C for Operational Necessity"

- **Flight Deck**
- **Ramp Tower**
- **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

**ATD-2 IADS Information Sharing**

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

**Ramp Tower**

"Hold 5 min for metering."

**5 min later ...**

"Pushback approved, expect Runway 18C."

**ATC Tower**

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

Pilots call for Pushback
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)*

**Pushback**
- Call Ramp for Pushback
  - Ramp Controller: Gate Hold Advisory*
    - Surface Metering
  - Ramp Controller: Expected RWY
  - Coordinate Push w/ Tug
  - Start First Engine

*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**

- ATD-2 Integrated Arrival, Departure, and Surface (IADS) Operations
- Pilot Procedures
- Wheels-Up Time Flowcharts

---

**Pilot Procedures**

- ATD-2 Integrated Arrival, Departure, and Surface (IADS) Operations - Flight Deck Coordination
- Typical Pushback Procedures
- Wheels-Up Time Procedures

---

**Wheels-Up Time Flowcharts**

- ATD-2 Integrated Arrival, Departure, and Surface (IADS) Operations - Flight Deck Coordination
Real-World Procedural Compliance

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

- 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
**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
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)

- EOBTs
  - Airlines
  - ATC Tower
  - Scheduler / Planning Algorithms
  - Ramp
  - Flight Deck

General Aviation / Business Jet Operations

- No Airlines to compute and share more accurate EOBTs (ready-times)
  - Filed departure time only
  - ATC Tower
  - Scheduler / Planning Algorithms

- No Ramp Controller to exchange information with Pilots
  - Flight Deck
  - General Aviation
  - Business Jet
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
General Aviation (GA) Information Sharing

Ready-to-Taxi Time (RTT)

<table>
<thead>
<tr>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Mobile App to enable information flow for GA flights.</td>
</tr>
<tr>
<td>• Ready-to-Taxi Time (RTT) similar to EOBT at the Main Ramp.</td>
</tr>
<tr>
<td>• The MITRE Corporation developing prototype 'Taxi Time' App</td>
</tr>
</tbody>
</table>


**Flight Deck**
General Aviation
Business Jet

**Ready-to-Taxi Time**

5:00 Z

**ATD-2 IADS Surface Scheduler / Planning Algorithms**
### ATD-2 IADS Information Sharing

<table>
<thead>
<tr>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Two-way information flow to send information back to pilots.</td>
</tr>
<tr>
<td>• Expected beta-testing 2018</td>
</tr>
<tr>
<td>• The MITRE Corporation developing prototype 'Taxi Time' App</td>
</tr>
</tbody>
</table>


---

#### Mobile App: Two-Way Information Flow

<table>
<thead>
<tr>
<th>Flight Deck</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Aviation Business Jet</td>
</tr>
</tbody>
</table>

**Ready-to-Taxi Time**

5:00 Z

- RWY 18L
- Takeoff 5:12
- Wheels-Up
- Arrival 7:04

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

Deborah L. Bakowski, M.A.
SJSU at NASA Ames Research Center

Becky L. Hooey, Ph.D.
NASA Ames Research Center

Robert W. Koteskey, M.A.
SJSU at NASA Ames Research Center

David C. Foyle, Ph.D.
NASA Ames Research Center

Human-Centered Systems Lab (HCSL) at NASA Ames Research Center

9th International Conference on Applied Human Factors and Ergonomics (AHFE)
July 21 – 25, 2018
Orlando, FL