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
ATD-2 IADS Traffic Management System

- 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
Efficient scheduling into constrained overhead flows.

Scheduling tools to efficiently manage 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 Scheduler** Produces airspace trajectory predictions to enable more precise scheduling into overhead traffic streams.

**Information Sharing** Increased sharing of data and decision information among users.

**Surface Modeler** Produces surface trajectory predictions.

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

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

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

**Ramp Tower**
Display/Interface
Ramp Traffic Console (RTC): Flight info, pushback advisories

**ATC Tower**
Display/Interface
Runway arrival/departure timelines, flight list, map

**ARTCC (Center)**
Display/Interface
Departs 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 pilot training and communication are needed?
- What procedures are required of pilots to support the ATD-2 IADS system?
Pilot Engagement and Outreach

- Subject Matter Expert Interviews
- Pilot Community Engagement at CLT
- (3) Pilot Webinar Briefings
- Distribute Pilot-Training Materials
- ATD-2 IADS Go Live at Charlotte (CLT)
- MITRE's General Aviation User Forum
- Measure Real-World Pilot Procedural Compliance

- May – July 2016
- Feb 2017
- April – July 2017
- Sept 2017
- Sept 2017
- Nov 2017
- May 2018
In our research discussions with Charlotte-based Commercial Pilots, we learned that some pieces of information were not reaching the Flight Deck as consistently, or as early, as they could. Runway Assignment is an example of one of those pieces of information.
At the Gate, prior to Pushback:
Pilots program Flight Deck computers and configure the aircraft for a particular Runway.

If the Runway Assignment issued by the Ground Controller is different than what Pilots planned for, there are implications for Flight Deck workload and traffic flow.

At the AMA Entrance:
Ground Controller issues the Runway Assignment.
Flight Deck Implications for Changing Runway:

- Request new performance numbers via ACARS
- Reprogram/Verify FMS
- Reconfigure MCP
- Runway-change Checklist (some airlines)
- Eyes-in time
- Pilot Strategies include:
  - Slow taxi speed
  - Stop aircraft
ATD-2 IADS Information Sharing

- Share information among all operators who are responsible for managing traffic to support efficient operations.
## ATD-2 IADS Information Sharing with Flight Deck Implications:

- Runway Assignment
- **TMI:** Expect Departure Clearance Time (EDCT)
- **TMI:** Wheels-Up Time for Flow Control (APREQ)
- Departure Fix Closures
- Ground Stop at Destination Airport
- Runway for Operational Necessity
- Anticipated Pushback Delay
- Surface Metering: Gold Hold Advisories
- Earliest Off-Block Time (EOBT)
Runway Assignment

<table>
<thead>
<tr>
<th>Prior to ATD-2 IADS</th>
<th>• Runway assignment was typically communicated to pilots by Ground Control at the spot or, sometimes, by Ramp Control.</th>
</tr>
</thead>
</table>
| 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."
Flight Deck Implications of ATD-2 IADS at CLT

Traffic Management Initiative (TMI)

Expect 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.

ATC Tower
- EDCT
- Pushback Advisory (for EDCT)

Ramp Tower
- You have an EDCT time of 1430, hold for 20 min.
- "Pushback approved, expect Runway 18C."

Airlines
- Wheels-Up Time (EDCT)

Flight Deck
- PRE-DEPARTURE CLR
  EDCT 14:30Z

Surface Scheduler / Planning Algorithms
- ATD-2 IADS Information Initiative (TMI)
Flight Deck Implications of ATD-2 IADS at CLT

Traffic Management Initiative (TMI)
APREQ/CFR: “Wheels-Up Time for Flow Control”

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

**TRAFFIC MANAGEMENT INITIATIVE (TMI)**

**APREQ/CFR: “Wheels-Up Time for Flow Control”**

| 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. |

---

**ATC Tower**

**Wheels-Up Time (APREQ)**

**Pushback Advisory (for APREQ)**

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

---

**Ramp Tower**

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

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>• Departure Fix closures were typically communicated to pilots by Ground Control at the spot or, sometimes, by Ramp Control.</th>
</tr>
</thead>
</table>
| 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. |

Pilots call for Pushback

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

Ground Stop at Destination Airport

Prior to ATD-2 IADS

• Ground Stops were communicated to pilots by Ground Control at the spot or, sometimes, by Ramp Control.

ATD-2 IADS Information Sharing

• Ramp Control is equipped with Ground Stop information.
• Ramp Control communicates to pilots when the destination airport is closed.

Pilots call for Pushback

"Ground Stop in effect at destination airport."
Specify Runway for Operational Necessity

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

As soon as known:

“Runway 18C for Operational Necessity”
# Flight Deck Implications of ATD-2 IADS at CLT

## Anticipated Pushback Delay

<table>
<thead>
<tr>
<th>Prior to ATD-2 IADS</th>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
</table>
| • Pilots, sometimes, informed Ramp Control of anticipated pushback delays (e.g., maintenance issue). | • Pilots inform Ramp Controller of anticipated pushback delay (as soon as known).  
• Ramp Control electronically communicates delay to ATC. |

**As soon as known:**

“We expect a 5 minute delay.”
## Flight Deck Implications of ATD-2 IADS at CLT

### Surface Metering: Gate Hold Advisories

<table>
<thead>
<tr>
<th>ATD-2 IADS Information Sharing</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Time-based Surface Metering throttles demand to the runway.</td>
</tr>
<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>
</tbody>
</table>

#### Pilots call for Pushback

**ATC Tower**

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

**Ramp Tower**

**Pushback Advisory**

(for Surface Metering)

5 min later...

"Hold 5 min for metering."

"Pushback approved, expect Runway 18C."
Pilot Outreach and Training

Pilot Communication Distributed Prior to ATD-2 Go Live at Charlotte on September 29th, 2017

- 15 airlines at Charlotte's main ramp (Mainline and Regional)
- 2 pilot organizations (distributed Operational Bulletins)
Real-World Procedural Compliance

TRAFFIC MANAGEMENT INITIATIVE (TMI)

APREQ/CFR: “Wheels-Up Time for Flow Control”

• Of flights subject to a **Wheels-Up Time for Flow Control (APREQ/CFR)**, percent that **had their Wheels-Up Time when they pushed back.**

63% Average
February 2018
Real-World Procedural Compliance

TRAFFIC MANAGEMENT INITIATIVE (TMI)

APREQ/CFR: “Wheels-Up Time for Flow Control”

- Flight is subject to a Wheels-Up Time for Flow Control
- **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.  
|            | • EOBTs (ready times) are ingested by the Surface Scheduler / planning algorithms. |

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

- Calculated by Airlines
- Calculated in real-time
Earliest Off-Block Time (EOBT)

**ATD-2 IADS**
- Best prediction of earliest expected pushback.
- EOBTs (ready times) are ingested by the Surface Scheduler / planning algorithms.

**Earliest Off-Block Time (EOBT):**
- Calculated by Airlines
- Calculated in real-time

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

**Ramp Tower**

**Flight Deck**
Main Ramp (Commercial Operations) at Charlotte

**EOBT (Ready time)**

- **Airlines**
- **ATD-2 IADS Scheduler / Planning Algorithms**
- **ATC Tower**
- **Ramp**
- **Flight Deck**

**ATD-2 IADS Information Flow**
ATD-2 IADS Information Flow

Main Ramp (Commercial Operations) at Charlotte

- **EOBT (Ready time)**
  - Airlines
  - ATC Tower
  - ATD-2 IADS Scheduler / Planning Algorithms
  - Ramp
  - Flight Deck
  - Commercial at the Main Ramp

General Aviation / Business Jet Operations at Charlotte

- No Airlines to compute and share accurate EOBT (Ready times)
  - ATC Tower
  - ATD-2 IADS Scheduler / Planning Algorithms
- No Ramp Controller to facilitate information exchange with Pilots
  - Flight Deck
  - General Aviation / Business Jet
ATD-2 IADS Information Flow

Main Ramp (Commercial Operations) at Charlotte

- Airlines
- ATC Tower
- ATD-2 IADS Scheduler / Planning Algorithms
- Ramp
- Flight Deck

- EOBT (Ready time)

General Aviation / Business Jet Operations at Charlotte

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

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>• <strong>The MITRE Corporation</strong> developing prototype 'Taxi Time' App</td>
</tr>
</tbody>
</table>

ATD-2 IADS Information Sharing

- Two-way information flow to send information back to pilots.
- Expected beta-testing 2018
- **The MITRE Corporation** developing prototype 'Taxi Time' App

Expanding IADS and the Mobile App

General Aviation / Business Jet Operations

- Larger proportion of GA operations at Dallas Love Field (DAL)
- Greater impact in ATD-2 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

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