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

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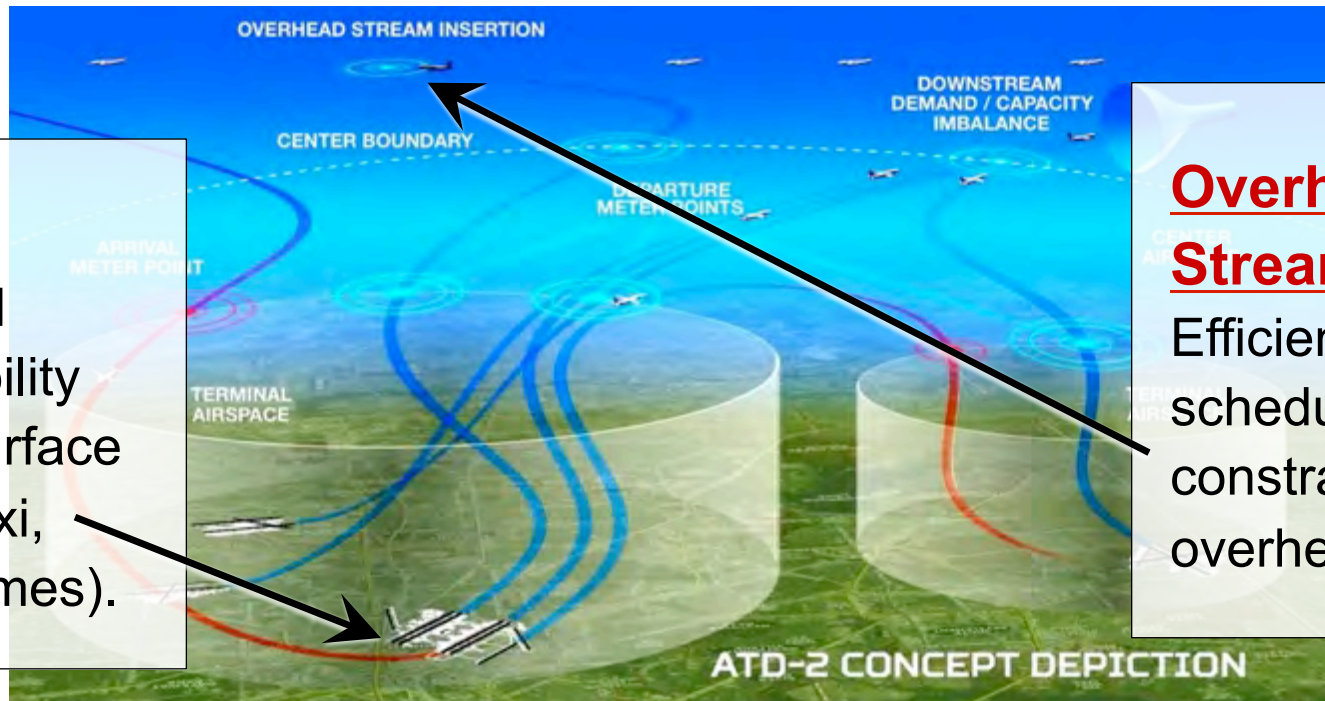
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NASA Ames Research Center

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
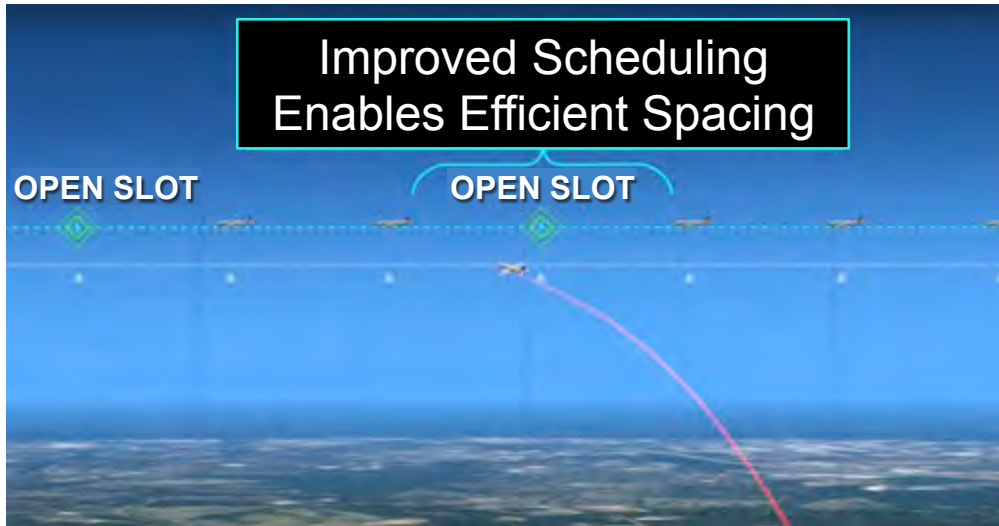

Surface
Improved predictability on the surface (push, taxi, takeoff times).

Overhead Stream
Efficient scheduling into constrained overhead flows.

ATD-2 CONCEPT DEPICTION

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**

Improved Scheduling Enables Efficient Spacing

OPEN SLOT   OPEN SLOT

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.

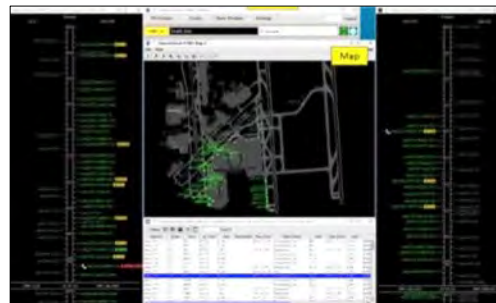**Surface Metering** Throttles demand to the runway.

ATD-2 IADS Displays and Interfaces

- **ATD-2 IADS improves predictability through a coordinated schedule between the Ramp, Tower, Terminal, and Center**
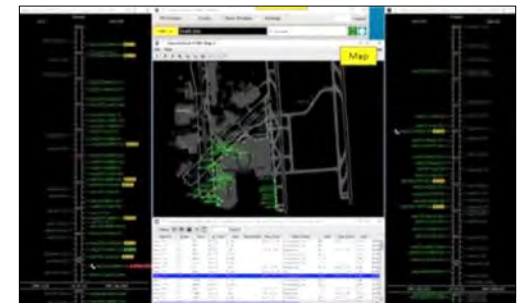
Ramp Tower
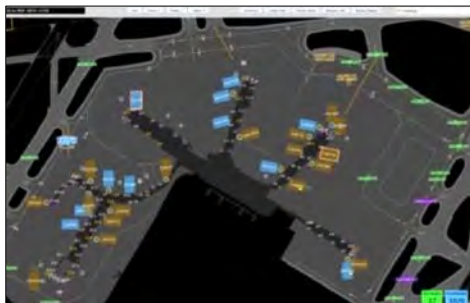
Display/Interface
Ramp Traffic Console
(RTC): Flight info,
pushback advisories

ATC Tower

Display/Interface
Runway arrival /departure
timelines, flight list, map

ARTCC (Center)

**Display/Interface**
Departures into
overhead streams

- 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
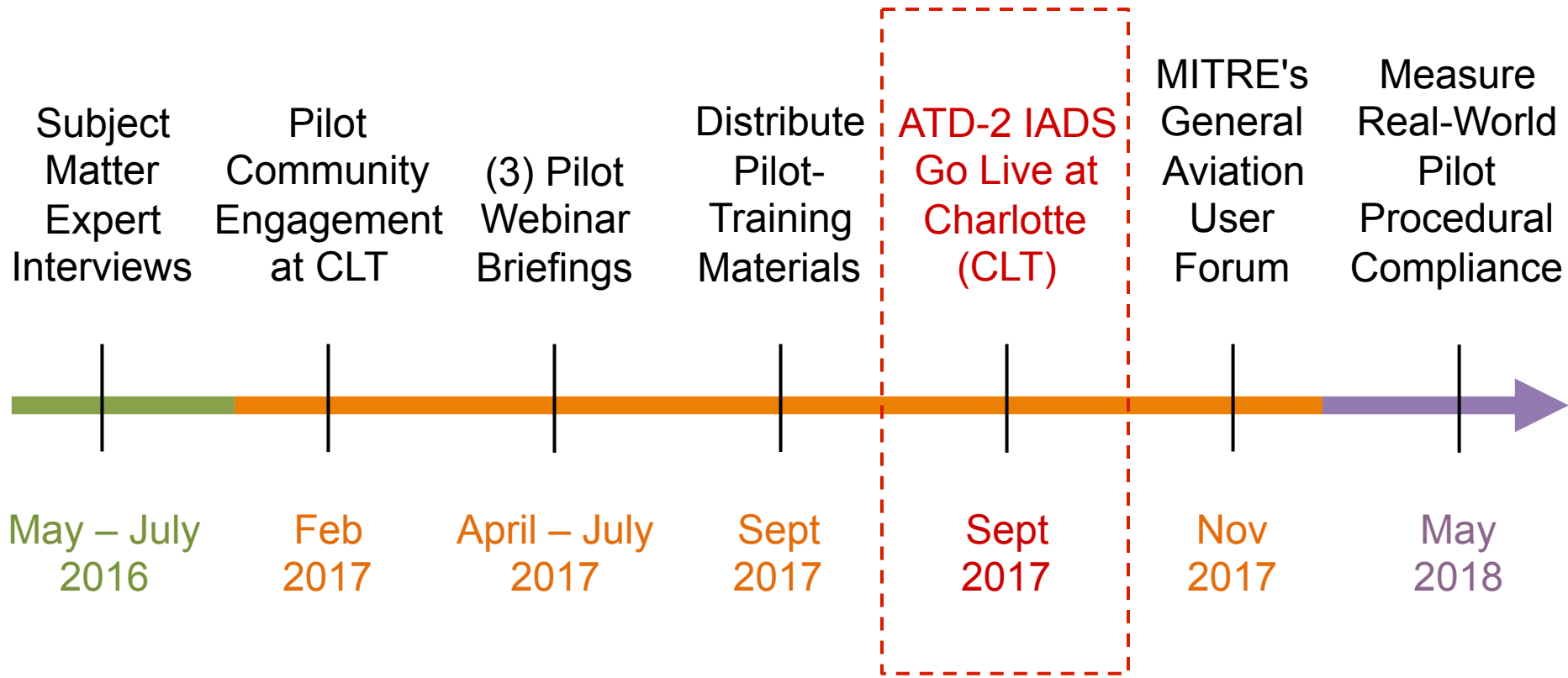
Charlotte Douglas International Airport (CLT)

18R · **18C** · **18L** · **23**

Main Ramp: Commercial Airlines

General Aviation / Business Jet Operations

36L · **36C** · **36R**
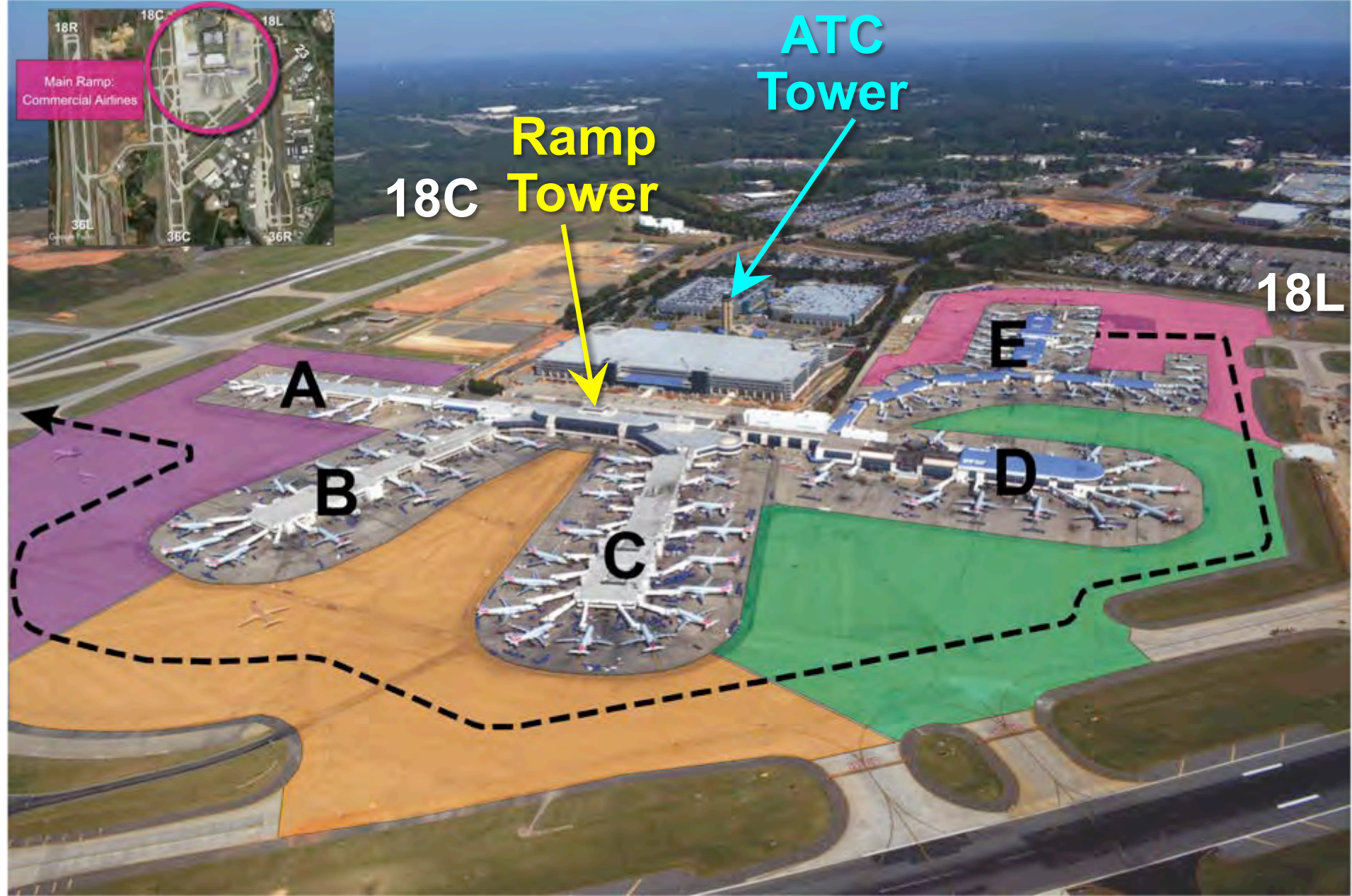
Google Earth

Charlotte Douglas (CLT) Main Ramp

Charlotte Douglas (CLT) Main Ramp

Airport Movement Area
Ground Controller (ATC Tower)
Taxi Clearance
Runway Assignment

ATC Tower

Ramp Tower

Gate
Ramp Controller (Ramp Tower)
Pushback Clearance

18L

A

E

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.

Charlotte Douglas (CLT) Main Ramp

Airport Movement Area
Ground Controller (ATC Tower)
Taxi Clearance
Runway Assignment

ATC Tower

Ramp Tower

Gate
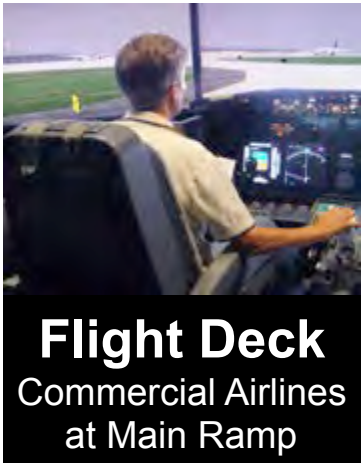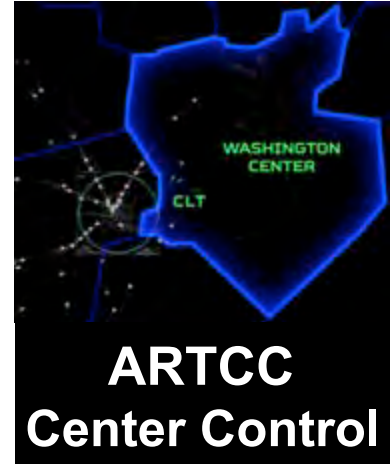**Ramp Controller (Ramp Tower)**
Pushback Clearance

18L

A

E

C

At the AMA Entrance:
Ground Controller issues the Runway Assignment.

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.

Charlotte Douglas (CLT) Main Ramp

Airport Movement Area
Ground Controller (ATC Tower)
Taxi Clearance
Runway Assignment

ATC Tower

Ramp Tower

Gate
Ramp Controller (Ramp Tower)
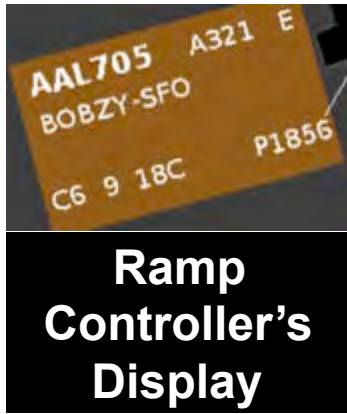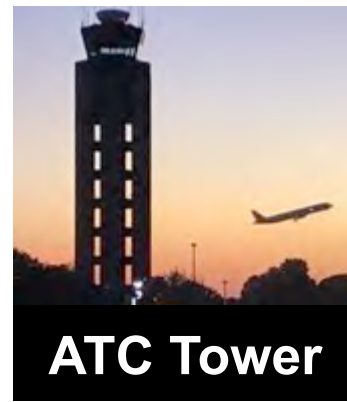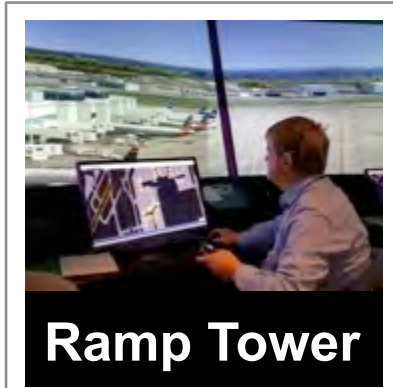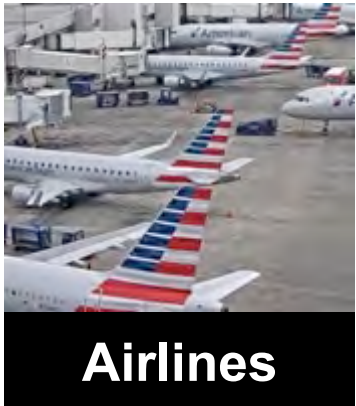Pushback Clearance

18L

A

E

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.

Airlines

Flight Deck
Commercial Airlines at Main Ramp

Ramp Tower

Ramp Controller's Display

AAL705 A321 E
BOBZY-SFO
C6 9 18C P1856

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

WASHINGTON CENTER
CLT

ARTCC Center Control

National Airspace Operations

ATD-2 IADS Information Sharing

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 *ATD-2 IADS*

- ⚡ Earliest Off-Block Time (EOBT) *ATD-2 IADS*

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

Runway Assignment

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Ramp Tower

AAL705   A321   E
BOBZY-SFO
C6   **18C**   P185

"Pushback approved, **expect Runway 18C**."

Flight Deck

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.

Wheels-Up Time (EDCT)

EDCT

Pushback Advisory (for EDCT)

📶 **Pilots call for Pushback Time Advisory**
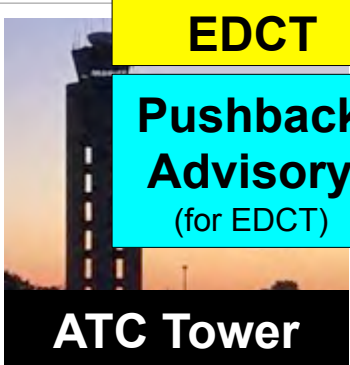
20 min later ...

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

"Pushback approved, expect Runway 18C."

Airlines

ATC Tower

Ramp Tower

PRE-DEPARTURE CLR

EDCT 14:30Z

Flight Deck

ATD-2 IADS Surface Scheduler / Planning Algorithms

20 min

AAL705 A321
BOBZY-SFO
E1430
C6 9 18C

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.

PRE-DEPARTURE CLR
CTC CD 127.15
JUST B4
PUSHBACK

Flight Deck *before* Pushback

Pilots call Clr. Delivery
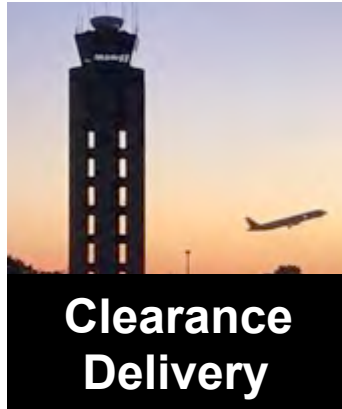
***Negotiation of APREQ (overhead slot)**

Clearance Delivery

ARTCC Center Control
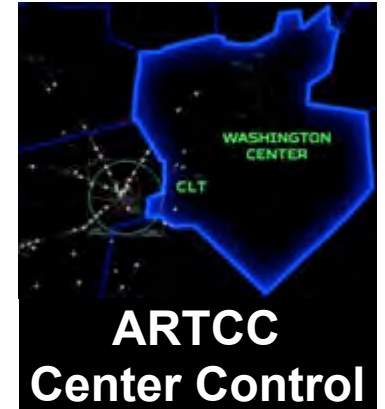
***Negotiation is not triggered until the Flight Deck contacts Clearance Delivery.**

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.

Wheels-Up Time (APREQ)
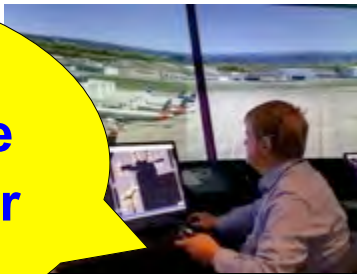
Pushback Advisory (for APREQ)

🔊 Pilots call for Pushback Time Advisory

10 min later ...

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

"Pushback approved, expect Runway 18C."

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Ramp Tower

AAL705 A321
BOBZY-SFO
10 min A2100
C6 9 18C

Departure Fix Change/Closure

Prior to ATD-2 IADS	• Departure Fix closures were 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 Departure Fix status. • Ramp Control communicates to pilots when Departure Fixes are closed or combined.

🔊 **Pilots call for Pushback**

Departure Fix Status

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Ramp Tower

AAL705 A321 E
BOBZY SFO
C6 9 18C P185

"Contact Clearance Delivery for new route, call when ready for push."

Flight Deck Implications of ATD-2 IADS at CLT
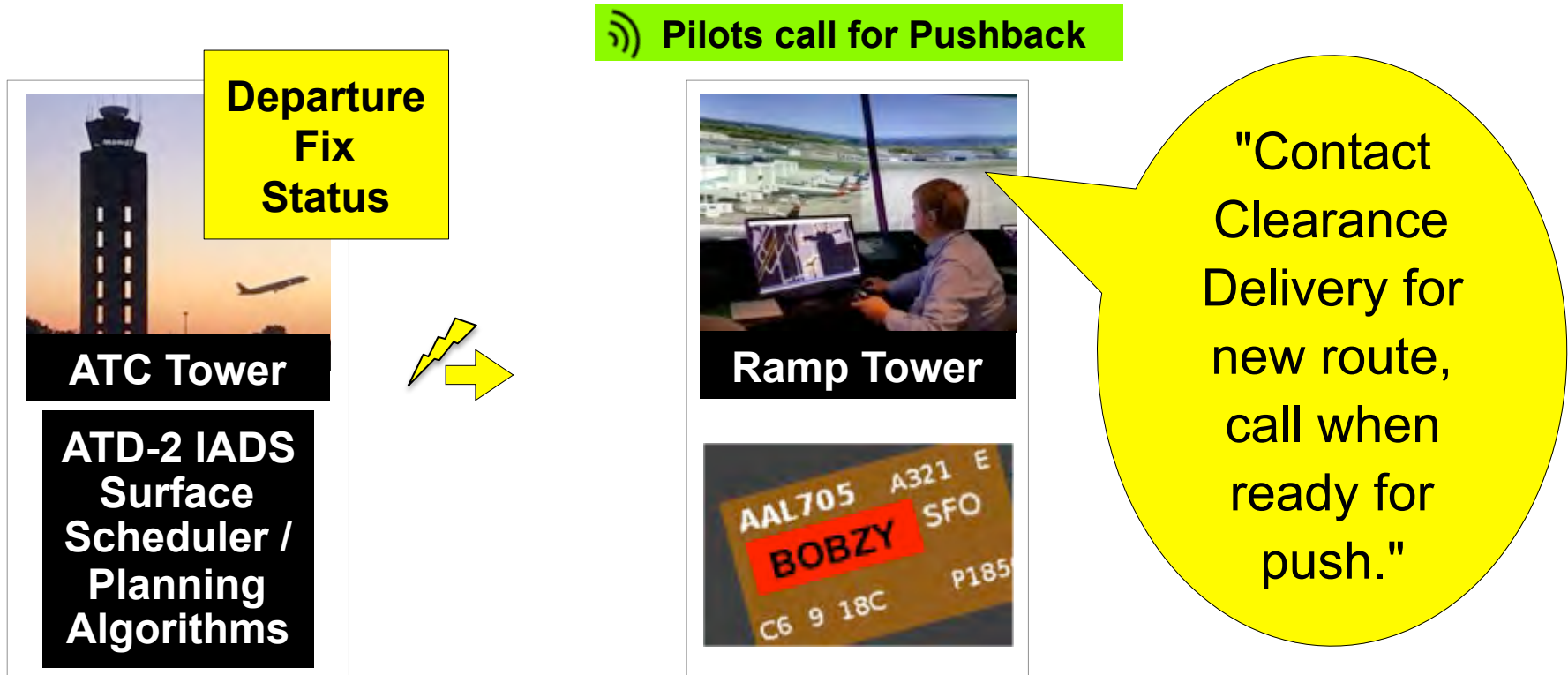
Ground Stop at Destination Airport

| 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 Status

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Ramp Tower

AAL705   A321   E
BOBZY   SFO
C6 9 18C   P185

"Ground Stop in effect at destination airport."

Specify Runway for Operational Necessity

Prior to ATD-2 IADS	• Pilots specified runway for operational necessity to Ramp Control or Ground Control.
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:

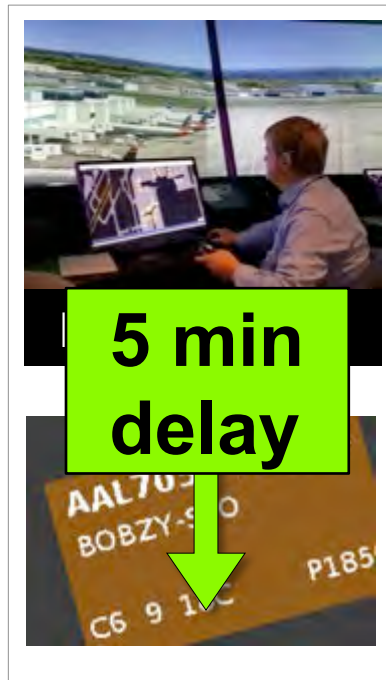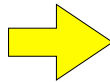"Runway 18C for Operational Necessity"

Flight Deck

Ramp Tower

18C

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms
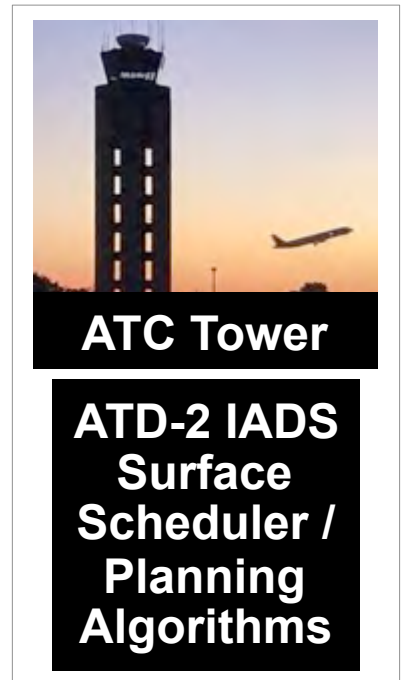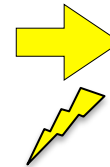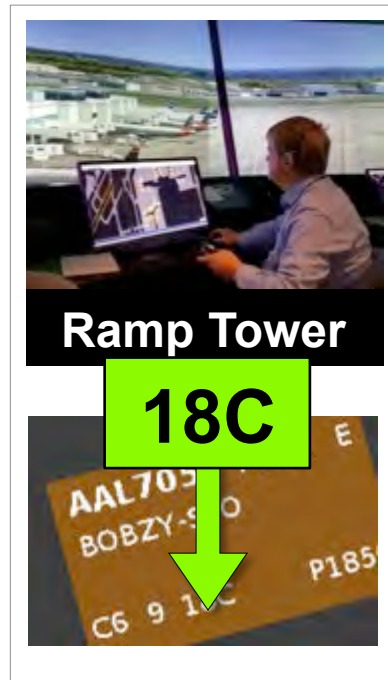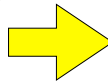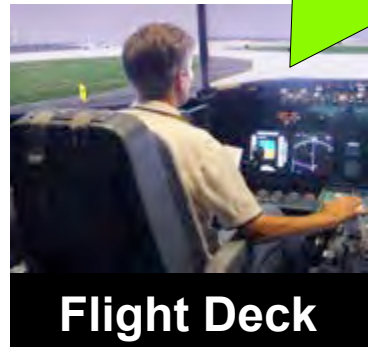
Anticipated Pushback Delay

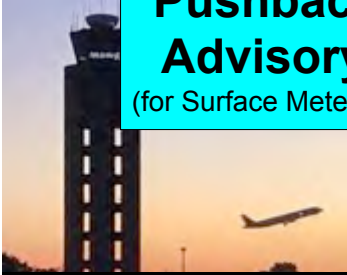| Prior to ATD-2 IADS	• Pilots, sometimes, informed Ramp Control of anticipated pushback delays (e.g., maintenance issue).
ATD-2 IADS Information Sharing	• Pilots inform Ramp Controller of anticipated pushback delay (as soon as known). • Ramp Control electronically communicates delay to ATC.

As soon as known:

"We expect a 5 minute delay."

Flight Deck

5 min delay

AAL70... BOBZY-... C6 9 1... P185

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

Flight Deck Implications of ATD-2 IADS at CLT
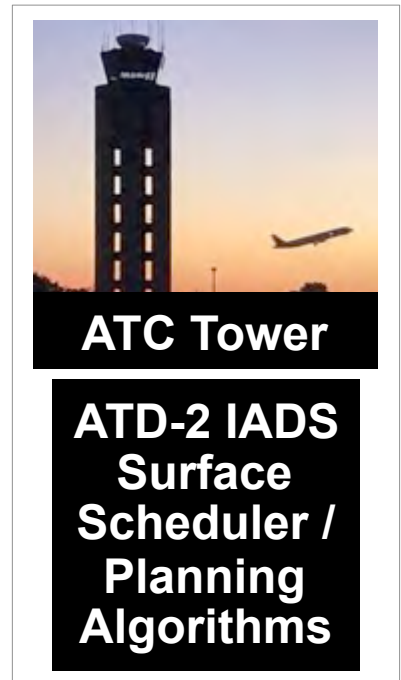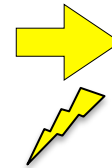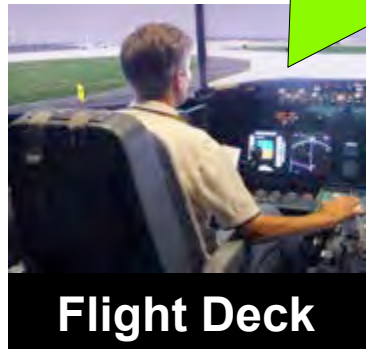
Surface Metering: Gate Hold Advisories

ATD-2 IADS (starburst badge)

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.

🔊 **Pilots call for Pushback**

Pushback Advisory
(for Surface Metering)

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

"Hold 5 min for metering."

Ramp Tower

5 min

AAL705   A321
BOBZY-SFO
C6 9 18C   P

5 min later ...

Ramp Tower

Push

AAL705   A321
BOBZY-SFO
C6 9 18C   P

"Pushback approved, expect Runway 18C."

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)

Overview and Expected Benefits

Pilot Procedures

Wheels-Up Time Flowcharts

Real-World Procedural Compliance

TRAFFIC MANAGEMENT INITIATIVE (TMI)
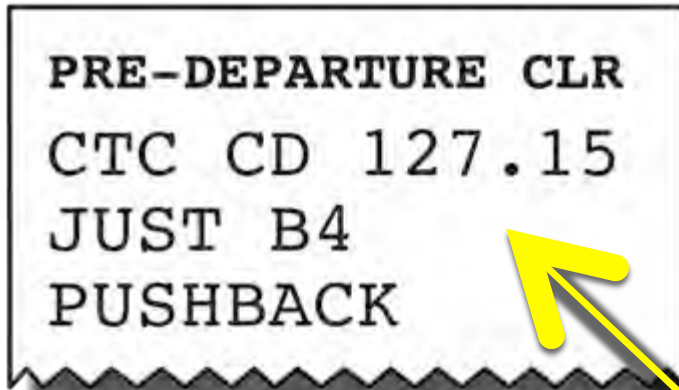
APREQ/CFR: "Wheels-Up Time for Flow Control"

- 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

TRAFFIC MANAGEMENT INITIATIVE (TMI)

APREQ/CFR: "Wheels-Up Time for Flow Control"


```
PRE-DEPARTURE CLR
CTC CD 127.15
JUST B4
PUSHBACK
```


- Flight is subject to a Wheels-Up Time for Flow Control

- **Action Required:** Contact Clearance Delivery just before pushback

Earliest Off-Block Time (EOBT)

ATD-2 IADS

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

EOBT

Airlines

ATC Tower

ATD-2 IADS Scheduler / Planning Algorithms

Flight Deck
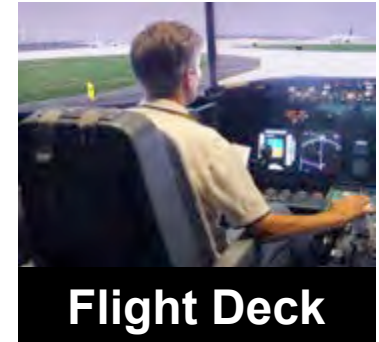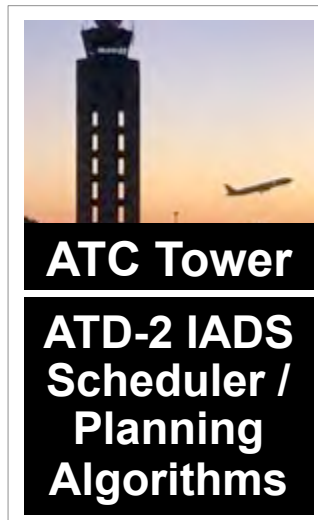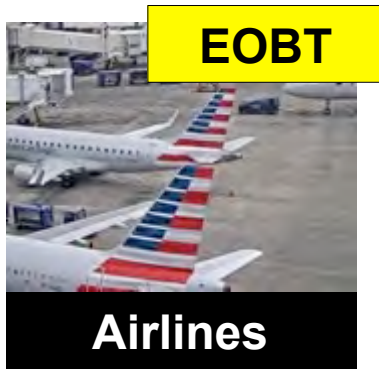
Earliest Off-Block Time (EOBT):

- Calculated by Airlines

- Calculated in real-time

Earliest Off-Block Time (EOBT)

ATD-2 IADS

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

EOBT

Airlines

ATC Tower

ATD-2 IADS Scheduler / Planning Algorithms

Flight Deck

Ramp Tower

Earliest Off-Block Time (EOBT):

- Calculated by Airlines
- Calculated in real-time

AAL705 A321
BOBZY-SFO
5 min C6 9 18C P1
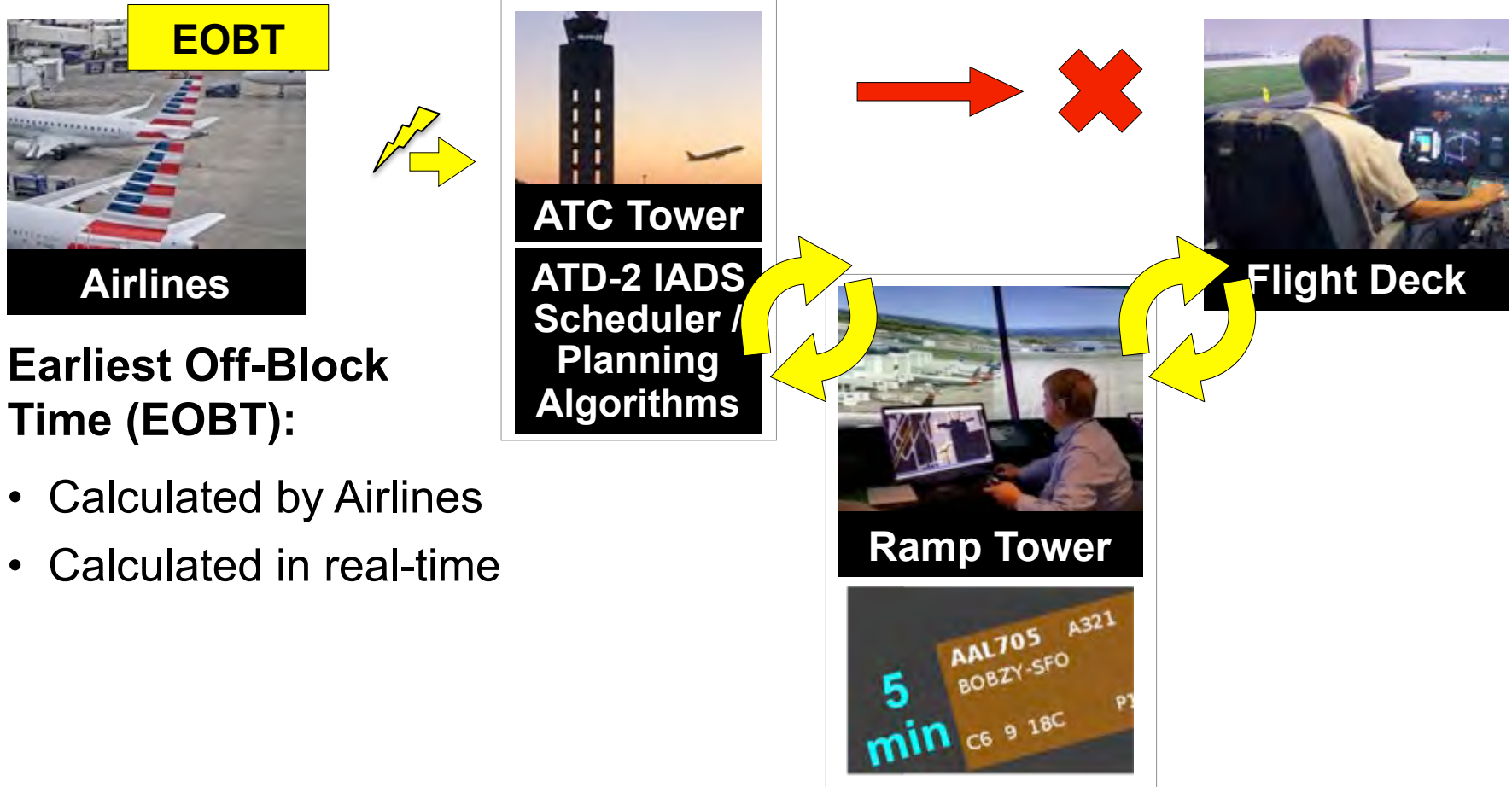
Charlotte Douglas International Airport (CLT)

Main Ramp (Commercial Operations) at Charlotte
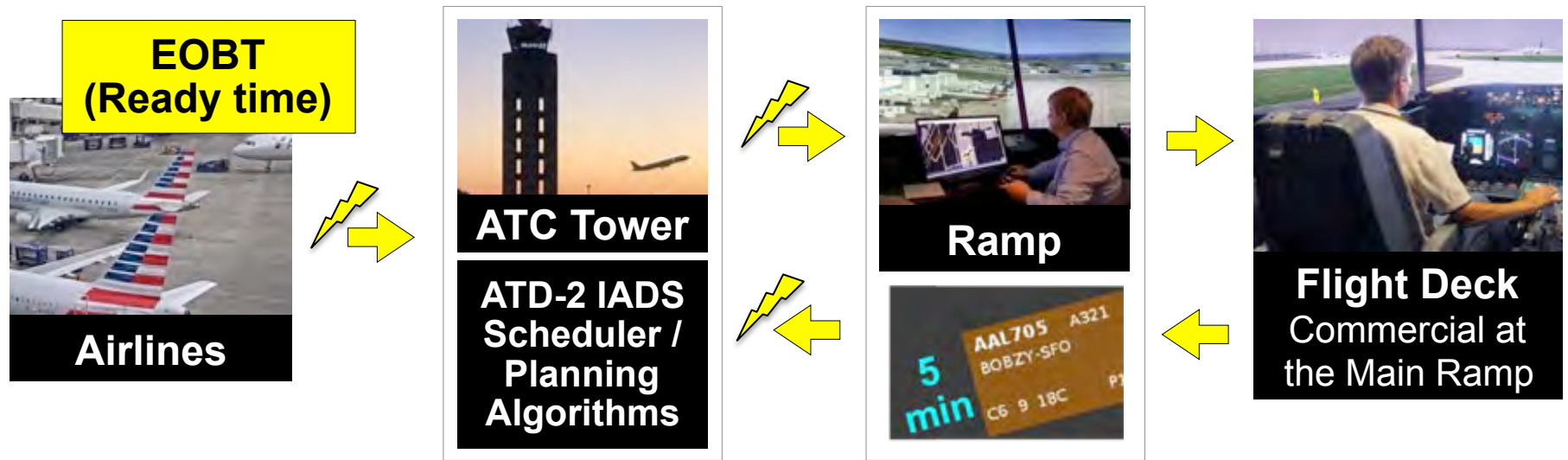
ATD-2 IADS Information Flow

Main Ramp (Commercial Operations) at Charlotte

EOBT (Ready time)

Airlines

ATC Tower

ATD-2 IADS Scheduler / Planning Algorithms

Ramp

AAL705   A321
BOBZY-SFO
5 min   C6 9 18C   P1

Flight Deck
Commercial at the Main Ramp

General Aviation / Business Jet Operations at Charlotte

No Airlines to compute and share accurate EOBT (Ready times)

Filed departure time only

ATC Tower

ATD-2 IADS Scheduler / Planning Algorithms
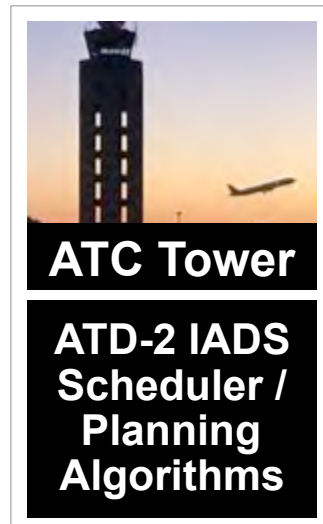
No Ramp Controller to facilitate information exchange with Pilots
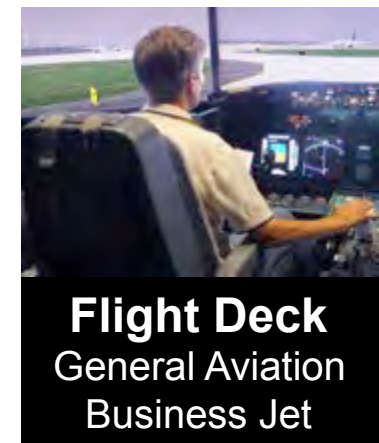
Flight Deck
General Aviation Business Jet

ATD-2 IADS Information Flow

Main Ramp (Commercial Operations) at Charlotte

EOBT (Ready time)

Airlines

ATC Tower

ATD-2 IADS Scheduler / Planning Algorithms

Ramp

AAL705 A321
BOBZY-SFO
5 min C6 9 18C P1

Flight Deck
Commercial at the Main Ramp
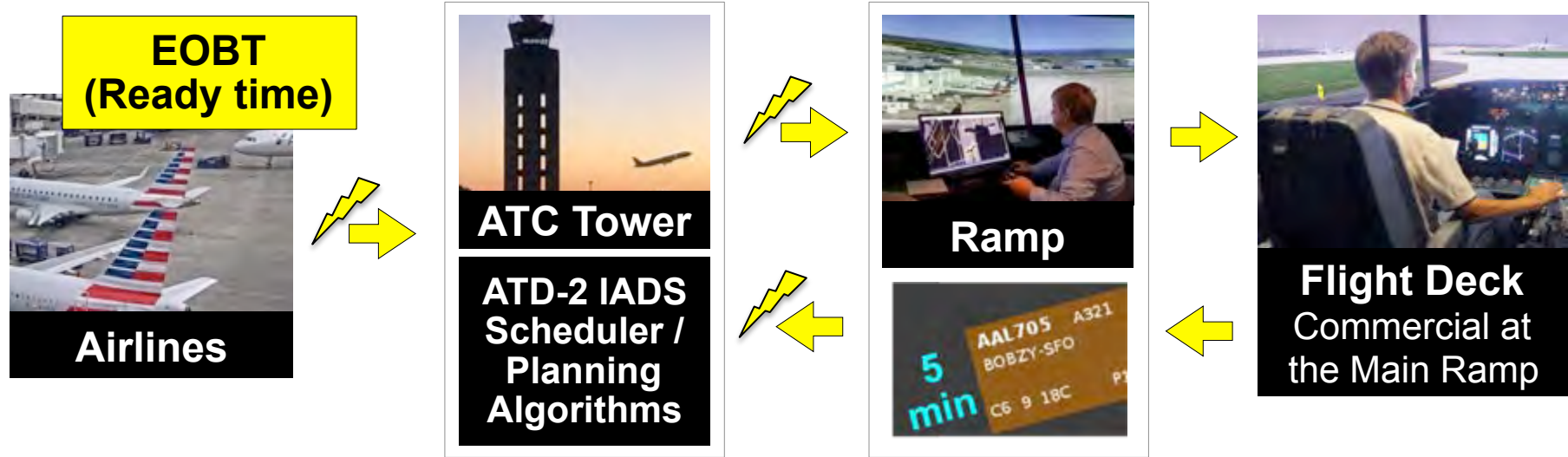
General Aviation / Business Jet Operations at Charlotte

Mobile Application for GA Pilots to facilitate information sharing

ATC Tower

ATD-2 IADS Scheduler / Planning Algorithms

Mobile App

Flight Deck
General Aviation Business Jet

Ready-to-Taxi Time (RTT)

ATD-2 IADS

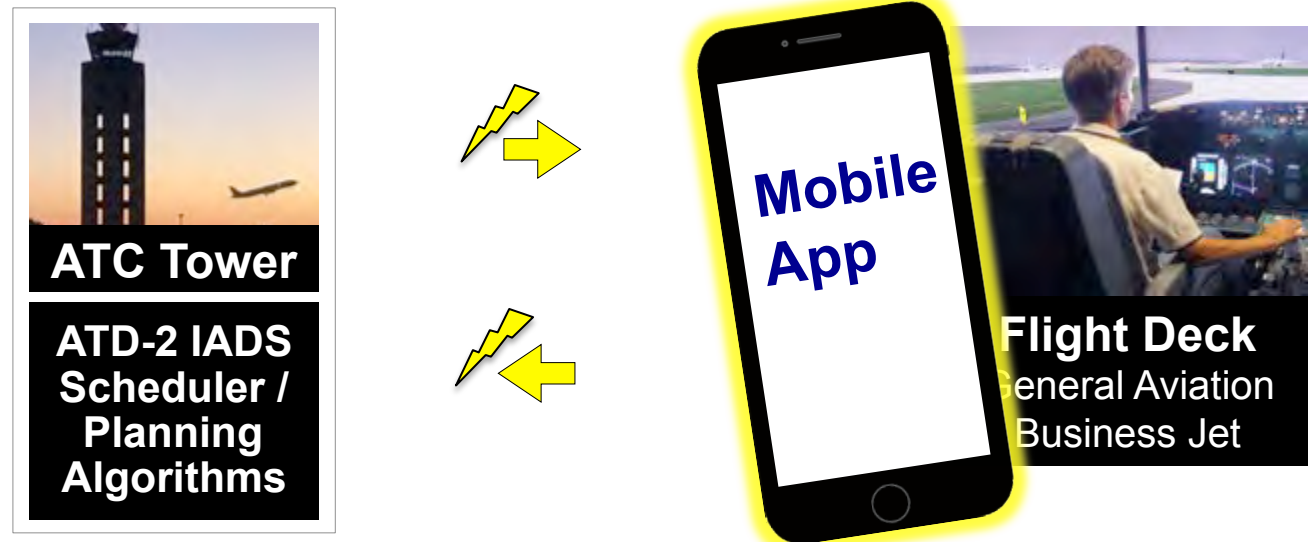| ATD-2 IADS Information Sharing	• Mobile App to enable information flow for GA flights. • Ready-to-Taxi Time (RTT) similar to EOBT at the Main Ramp. • **The MITRE Corporation** developing prototype '*Taxi Time*' App Diffenderfer, P.A., Long, K.M., & Wilkins, S.A. (2018). Concepts for delivering IFR clearances and exchanging pre-departure data using mobile devices. *Proceedings of the 2018 IEEE/AIAA Integrated Communications, Navigation, and Surveillance Conference (ICNS)*.

Ready-to-Taxi Time

5:00 Z

MITRE Corporation

Flight Deck
General Aviation Business Jet

ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

General Aviation (GA) Information Flow

Mobile App: Two-Way Information Flow

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 Diffenderfer, P.A., Long, K.M., & Wilkins, S.A. (2018). Concepts for delivering IFR clearances and exchanging pre-departure data using mobile devices. *Proceedings of the 2018 IEEE/AIAA Integrated Communications, Navigation, and Surveillance Conference (ICNS)*.

Flight Deck
General Aviation
Business Jet

Ready-to-Taxi Time

5:00 Z

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

MITRE Corporation

• **Runway Assignment**
• **Target Takeoff Time**
• **Wheels-Up Time**
• **Expected Arrival**
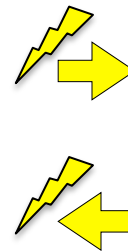
ATC Tower

ATD-2 IADS Surface Scheduler / Planning Algorithms

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%

- Airspace Technology Demonstration 2 (**ATD-2**)

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