Field Evaluation of the Baseline Integrated Arrival, Departure, and Surface (IADS) Capabilities at Charlotte Douglas International Airport (CLT)

Yoon Jung, William Coupe, Al Capps,
Shawn Engelland, Shivanjli Sharma

NASA Ames Research Center

Challenges in Today's Operations

- Airport congestion and excess queue time due to lack of a planning tool to even out the demand
- Reactive decision making due to limited data sharing and lack of coordination among stakeholders
- Low compliance to release time due to uncertainty in gate departure time and limited coordination

NASA's Airspace Technology Demonstration 2 (ATD-2) provides the Integrated Arrival, Departure, and Surface (IADS) solution for operational efficiency and predictability of metroplex operations

Outline

- What is Airspace Technology Demonstration 2 (ATD-2)?
- Phase 1 Baseline Capabilities
- Phase 1 Baseline Field Evaluation Results
- Summary and Next Steps

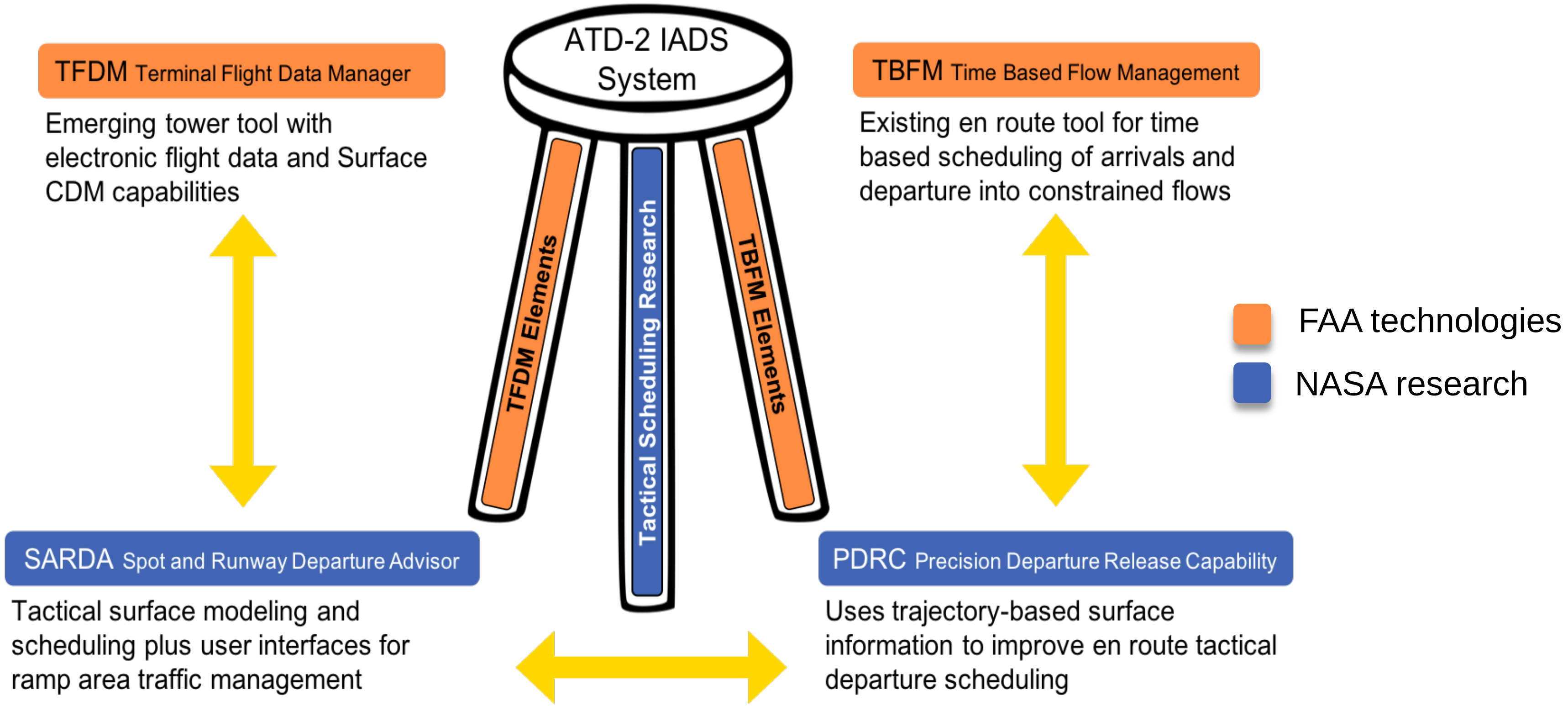
Outline

- What is Airspace Technology Demonstration 2 (ATD-2)?
- Phase 1 Baseline Capabilities
- Phase 1 Baseline Field Evaluation Results
- Summary and Next Steps

What is Airspace Technology Demonstration 2 (ATD-2)?

- Demonstrates IADS capabilities based on Trajectory-Based Operations (TBO) technologies and procedures

- Integrates NASA's previous IADS research and FAA's technologies



Outline

- What is Airspace Technology Demonstration 2 (ATD-2)?
- Phase 1 Baseline Capabilities
- Phase 1 Baseline Field Evaluation Results
- Summary and Next Steps

Phase 1 IADS Capabilities:

Data Exchange and Integration

- A single system running with multiple users (i.e., Tower, Ramp, TRACON, Center) to interact with one another
- Users share the same data, exchange information, and make decisions collaboratively
- Inputs are from multiple sources, including FAA, Airlines, ATC, and Ramp

Ramp Traffic Console (RTC) and Ramp Manager Traffic Console (RMTC)

Surface Trajectory-Based Operation (STBO) Client - Tower, TRACON, and Center

Phase 1 IADS Capabilities:

Collaborative Surface Metering

- Reduce excess taxi-out time by shifting taxi time from the departure queue to gates while engines are off
- Generate target pushback and spot times and provide pushback advisories to the ramp controller
- Planning horizon for surface metering can vary between tactical and strategic surface CDM
- Metering parameters determined collaboratively between Ramp and Tower, e.g., target excess queue time

Phase 1 IADS Capabilities:
Departure Scheduling for Overhead Stream Insertion

ATD2 Integrated Arrival/Departure/Surface

Facilitates automated coordination between Tower and Center for the release time (i.e., controlled takeoff time) of the departures subject to flow restrictions

1. **Prior to pushback the pilot contacts Tower and Tower electronically submits a release time request to Center**

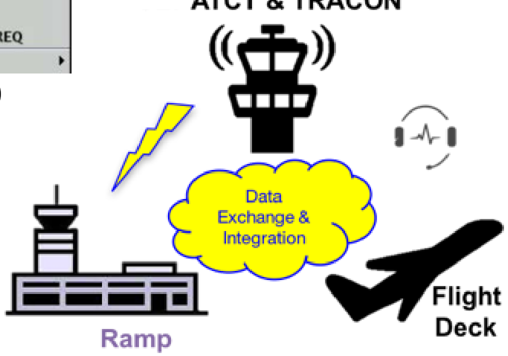
2. **Center approves or adjusts the time based on Center constraints**

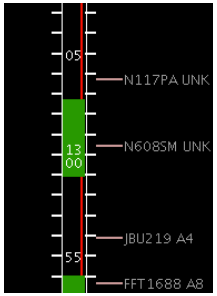
3. **Tower and Ramp utilize the now visible release time on their strips and pushback advisories**

4. **Release time can be renegotiated with Center for an earlier slot as necessary**

The data is made available on the SWIM feed so that Operators can get it to their pilots

STBO Client (Timeline)





SWIM

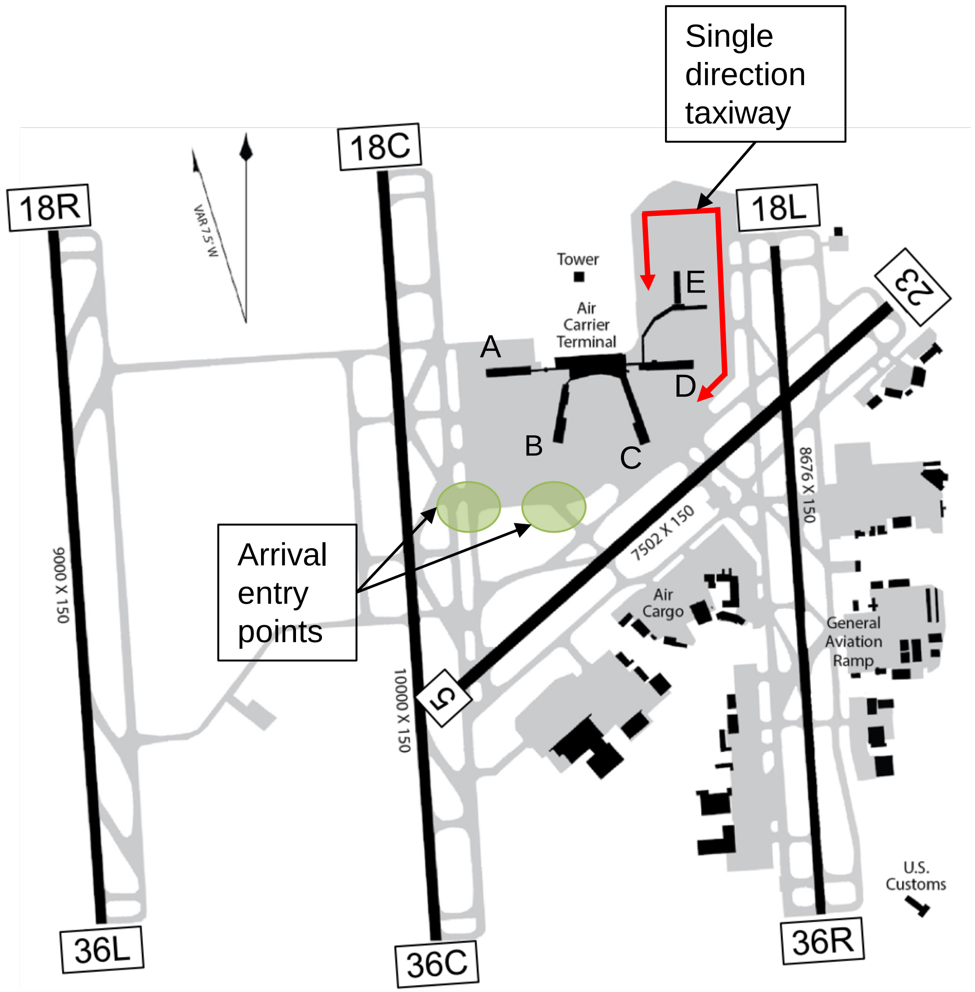
Outline

- What is Airspace Technology Demonstration 2 (ATD-2)?
- Phase 1 Baseline Capabilities
- Phase 1 Baseline Field Evaluation Results
- Summary and Next Steps

Phase 1 Baseline Field Evaluation

- Phase 1 Baseline IADS system deployed in CLT facilities for operational evaluation (Sept 2017)
- Phase 1 evaluation conducted through Sept 2018
- Field evaluation conducted in micro-phases:
  - 1A (Sept 2017): Data exchange and integration
  - 1B (Oct 2017): Departure scheduling for overhead stream insertion
  - 1C (Nov 2017): Collaborative surface metering

Charlotte International Airport (CLT)



- Sixth largest airport in US in operations (~1,600 ops/day)
- 9 banks of departures and arrivals
- Three primary runway configurations:
  - South Sim: 18L, 18C, 18R
  - South Converging: 18L, 18C, 18R, 23
  - North: 36L, 36C, 36R
- Ramp control challenges:
  - Single direction taxiway
  - Very limited holding areas
  - Single direction for wide body aircraft off C-Concourse
  - All arrivals enter from the west side of airfield during south flow

ATD2 Integrated Arrival/Departure/Surface

Phase 1 IADS Benefit Mechanisms

1 Collaborative surface metering
- Reduced engine run time
- Reduced fuel consumption and emissions
- More time for passenger boarding and baggage loading

2. Departure Scheduling for Overhead stream insertion

2a Scheduling controlled flights at the gate
- Reduced engine run time
- Reduced fuel consumption and emissions

2b Renegotiating release time for an earlier slot
- Reduced total delay
- Reduced engine run time
- Reduced fuel consumption and emissions
- Passenger value of time and crew costs

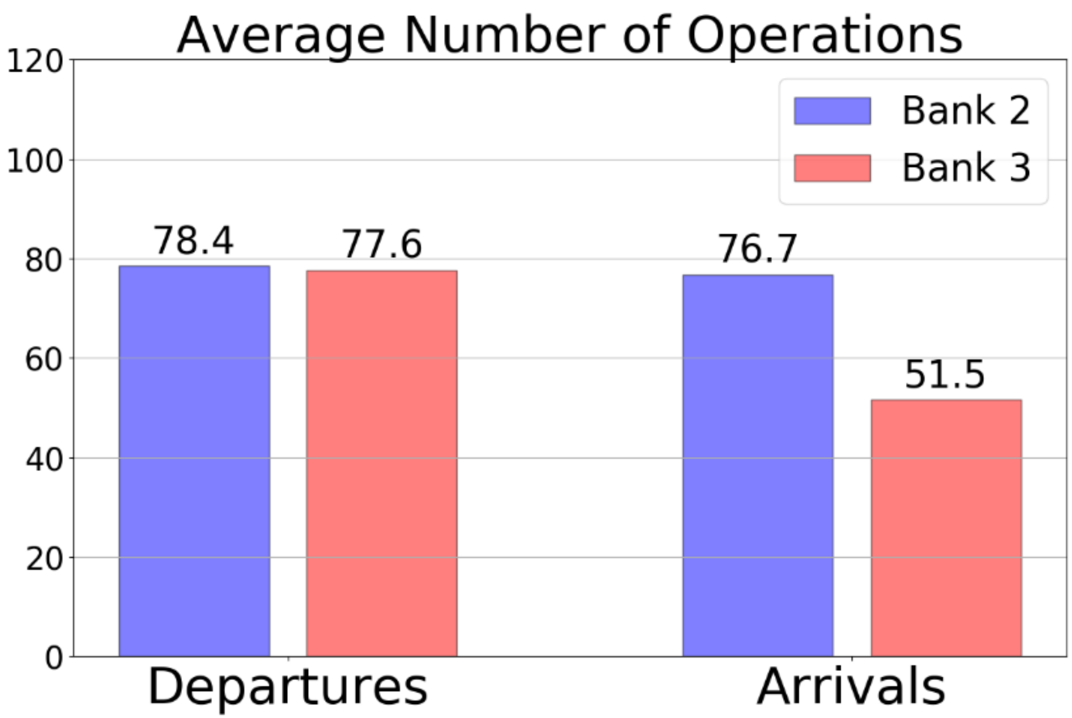
Benefits 1 and 2a achieved through gate holds

Benefit 2b achieved through release time renegotiation process

Phase 1 Surface Metering Usage

Surface metering in CLT started in late Nov 2017

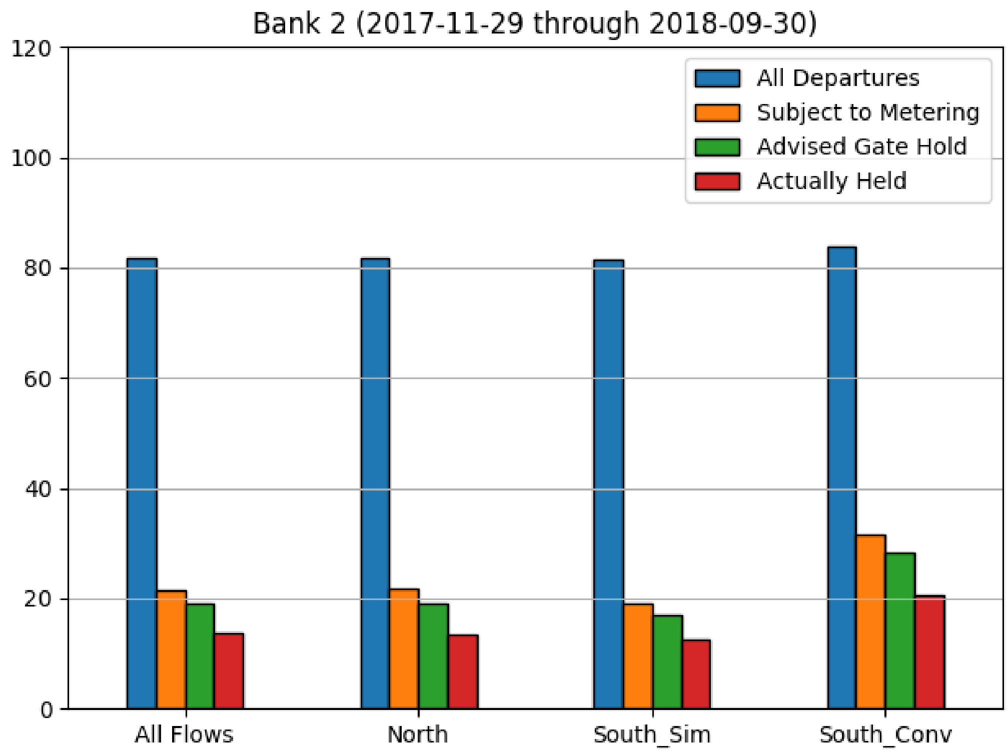
- Bank 2 was metered in 258 of 303 (85.1%) days since 2017-11-29
- Bank 3 was metered in 170 of 223 (76.2%) days since 2018-02-19



Avg. Number of Metered Flights

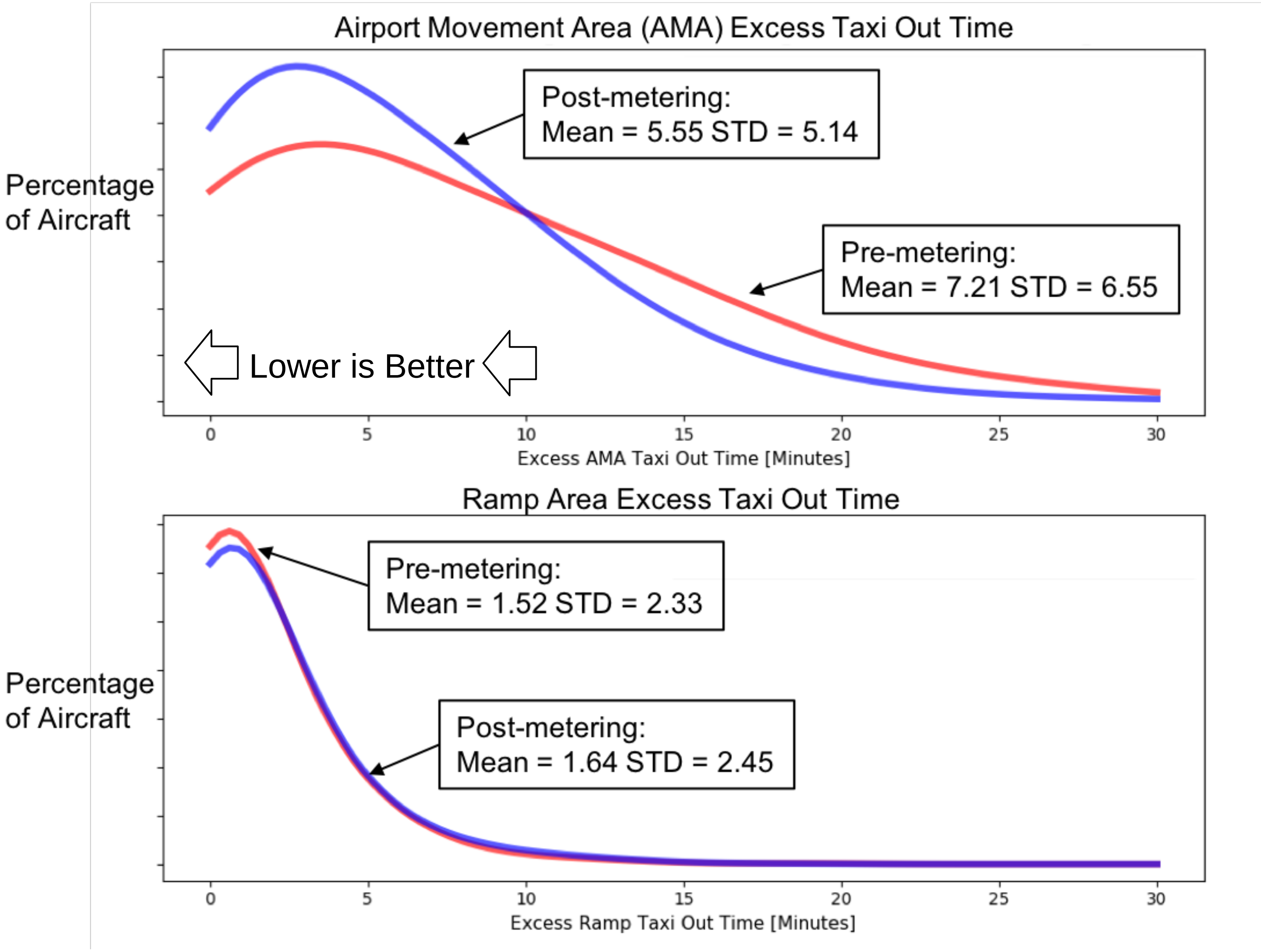
Among all the departures in Bank 2 (Bank3)

- 26.3% (16.3%) of departures were subject to metering
- 23.2% (14.4%) of departures were advised a gate hold
- 16.6% (10.4%) were actually held at the gate



Bank 2 North Flow Excess Taxi Out Time

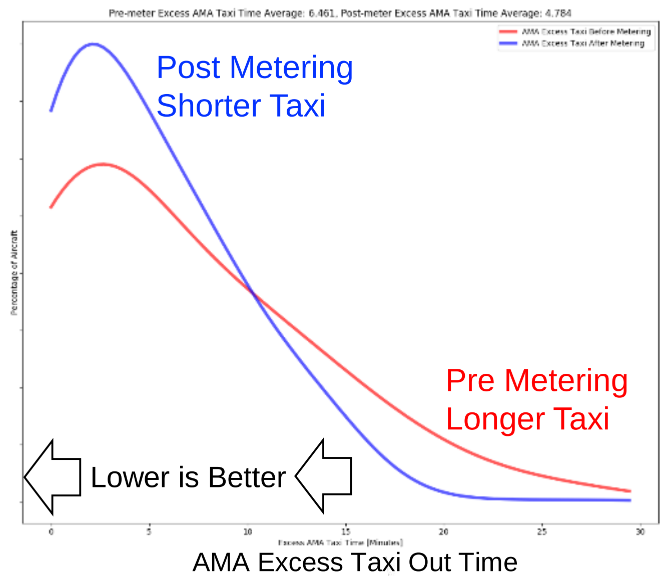
Excess taxi out time = Actual taxi out time – Undelayed taxi out time



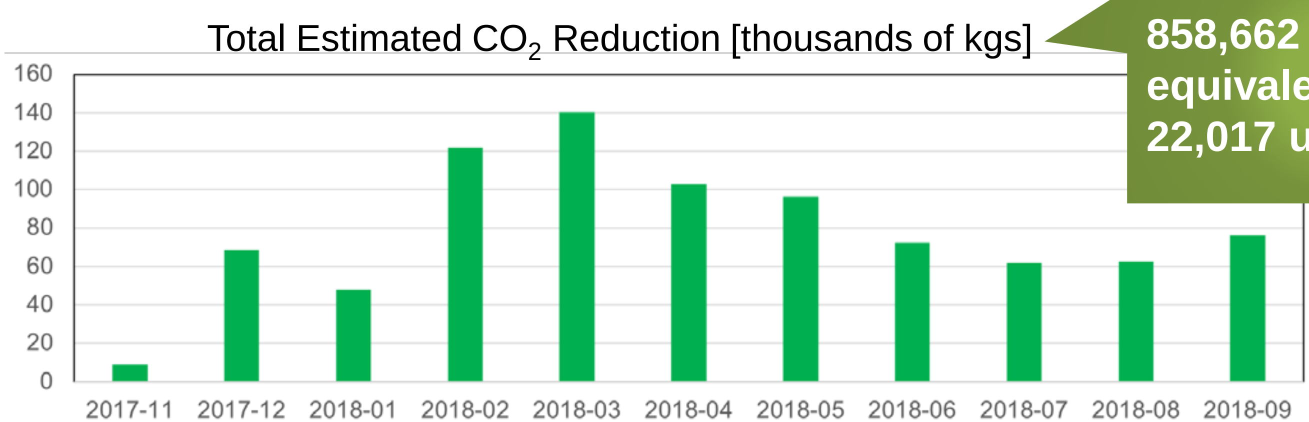
Collaborative Surface Metering Phase 1 Benefits (Banks 2 & 3)

Benefit 1

Reduced AMA taxi out times during its use via small holds at gate



Saved approximately 278,786 kgs of fuel by holding 14.2% of departures with average gate hold of 6 minutes



Reduced approximately 858,662 kgs of CO2, equivalent to planting 22,017 urban trees

Departure Scheduling for Overhead Stream Insertion – Phase 1 Benefits

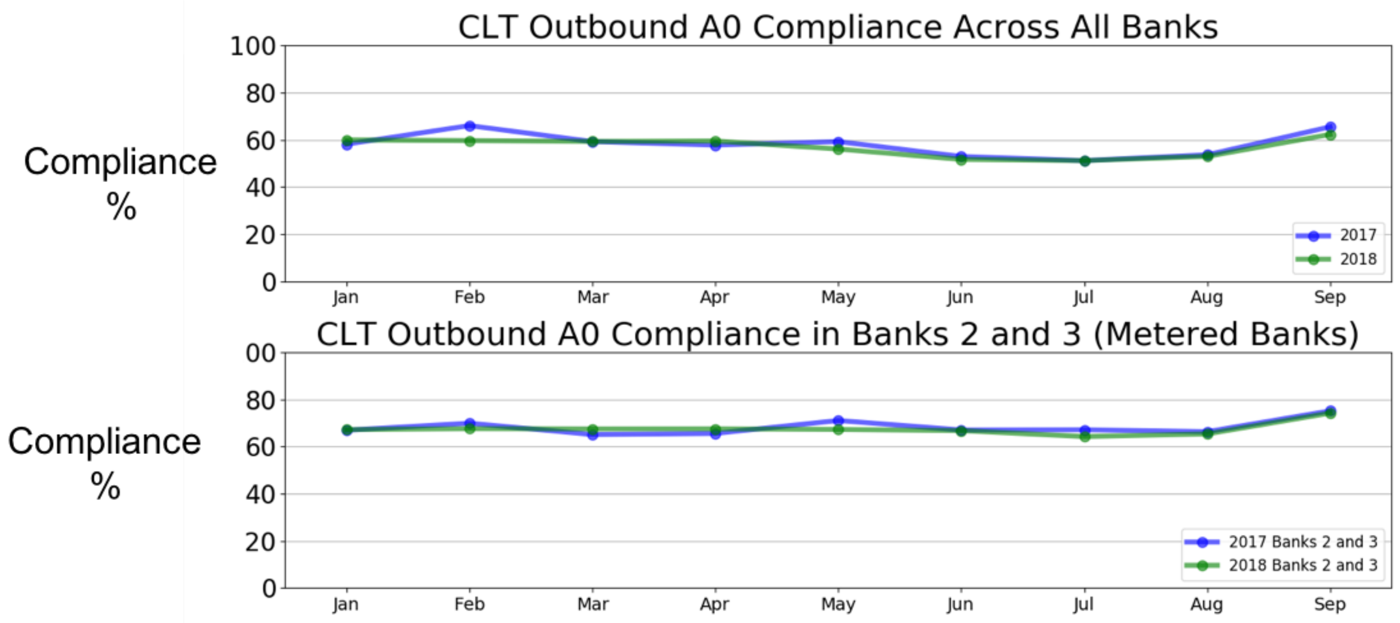
Benefit Mechanism	Taxi time reduction (hr)	Fuel savings (Kg)	CO_2 reduction (kg)	Urban trees
Gate hold **Benefit 2a**	298.52 (12,865)	201,002.08	619,086.41	15,874
Renegotiation **Benefit 2b**	92.59 (658)	59,126.64	182,110.05	4,669
Total	391.11	260,128.72	801,194.46	20,543

( ) Number of flights affected

- The benefits described here are associated with better use of existing capacity in the overhead stream, and technology to reduce surface delay
- These benefits are in addition to (distinct from) surface metering savings

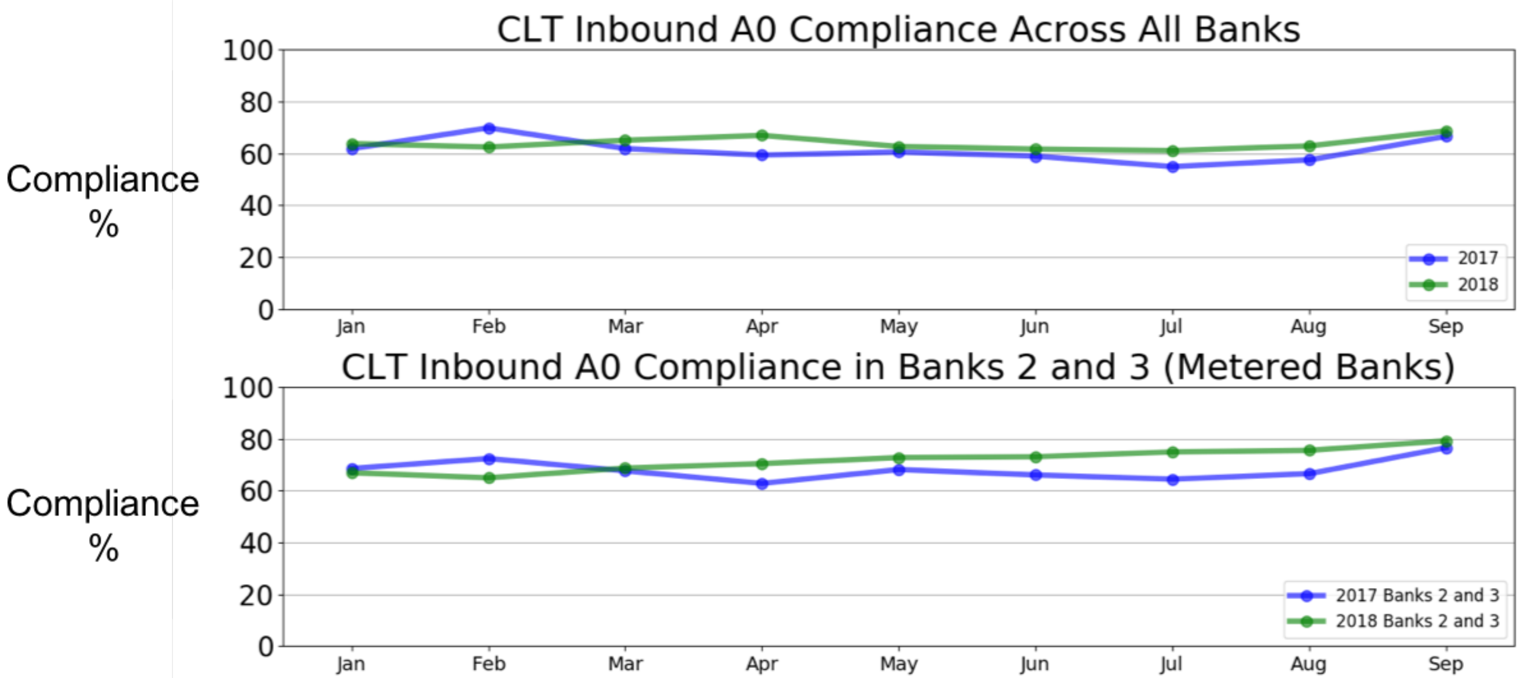
Outbound A0 On Time Performance

- A0 metric = Aircraft arrives in gate at or earlier than scheduled arrival time
- Used FAA's Aviation System Performance Metrics (ASPM) database



	2017 Compliance	2018 Compliance	YoY Change
Across All Banks	58.0%	56.9%	-1.1%
Banks 2 & 3	68.2%	67.4%	-0.8%

Inbound A0 On Time Performance



	2017 Compliance	2018 Compliance	YoY Change
Across All Banks	61.0%	63.9%	+2.9%
Banks 2 & 3	67.9%	71.9%	+4.0%

No negative impact on arrival ON time performance due to gate hold

Summary

- Phase 1 Baseline IADS system was developed in collaboration with FAA, ATC, Airlines, Ramp, pilot community, and Surface CDM Team

- Throughout a year-long field evaluation ATD-2 IADS system demonstrated Phase 1 objectives:
  - Improved data exchange and integration
  - Reduced taxi out time, fuel burn & emissions via surface metering
  - Reduced taxi out time, fuel burn & emissions via automated coordination of release times

- System performance and benefits were measured, and the results showed improvements in operational efficiency and predictability

- Phase 1 Technology Transfer was made to the FAA and industry partners: https://aviationsystemsdivision.arc.nasa.gov/publications/atd2/tech-transfer1/

Next Steps – Phase 2 Enhancement

- Refinement of surface scheduler is an on-going effort *(Note: A companion paper by William Coupe in Track 3, 11:15am, Thursday)*

- Usage of surface metering extended to other banks beyond Banks 2 & 3

- Planning horizon for demand-capacity prediction has been extended to enable strategic surface metering

- Flight operator plans to leverage surface metering by freezing gate hold advisories

- Enhanced predictability in flight ready time has allowed pre-scheduling of controlled flights

- Additional capabilities have been deployed in the field for operational evaluation:
  - Integration with Advanced Electronic Flight Strips (AEFS)
  - Terminal TFDM Publication (TTP)
  - Mobile App for General Aviation

Questions?

For more information visit:

https://aviationsystemsdivision.arc.nasa.gov/research/atd2/index.shtml

Backup Slides

Past and Present IADS R&D

- Surface Departure Queue Management

Collaborative Departure Queue Management (CDQM)	2010	FAA	MEM
Pushback Rate Control (N-Control)	2010	MIT	BOS
Spot and Runway Departure Advisor (SARDA)	2012, 2014	NASA	DFW, CLT
Controller Assistance for Departure Optimization (CADEO)	2004, 2008, 2009	DLR / Eurocontrol	ESSA, PRG, LGAV,
Airport Collaborative Decision Making (A-CDM)	2007 - present	Eurocontrol	18 airports (as of 2016)
Terminal Flight Data Manager (TFDM)	2021 - 2025	FAA	27 airports

- NASA's Arrival and Departure Scheduling

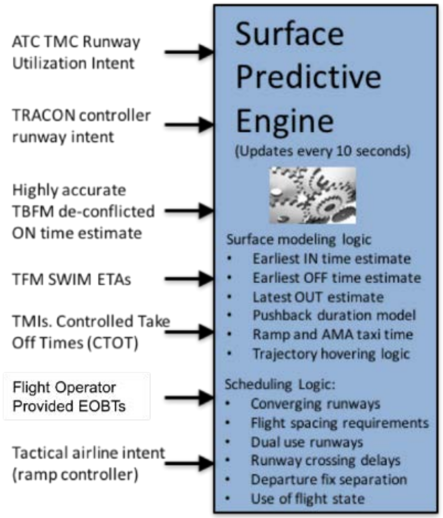
Terminal Sequencing and Spacing (TSAS)	2009 - 2015	Terminal area scheduling and controller managed spacing
Precision Departure Release Capability (PDRC)	2011 - 2013	Tactical departure scheduling for overhead stream insertion

Deployment of ATD-2 System for Phase 1 Field Evaluation

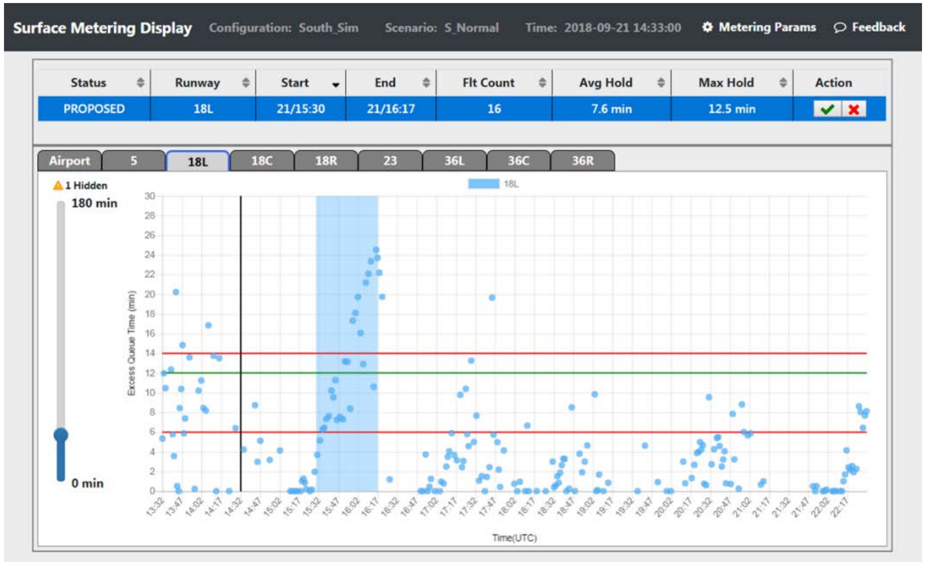
Facility	User	Display/Function
CLT Tower	Tower TMC	STBO Client, RMTC
		• Release time coordination with Center • Surface metering
CLT TRACON	Traffic Management Unit (TMU)	STBO Client, RTMC
ZDC Center	TMU	STBO Client
		Release time coordination with Tower
CLT AAL Ramp Tower	Ramp controller and Manager	RTC, RMTC, STBO Client
		Surface metering

Surface Metering – Process Flow

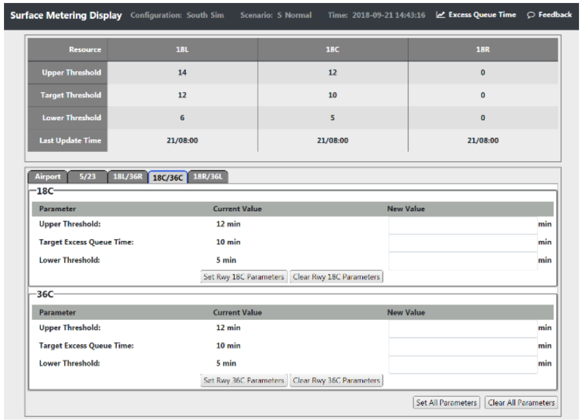
1 Generate Demand and Capacity Predictions



2 Monitor Surface Demand Capacity Imbalances

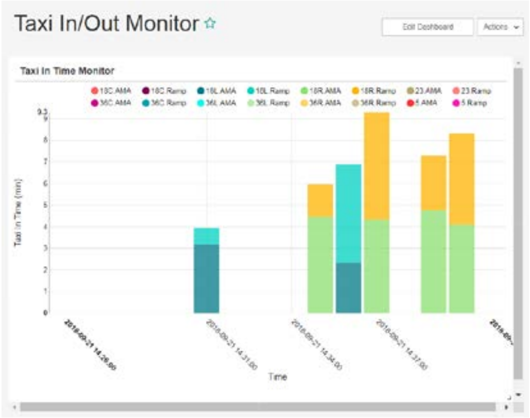


3 Enable Metering. Set Hold Level



4 Honor TMAT advisories

5 Evaluate Metering Effectiveness



Compliance of Gate Hold Advisory (TOBT)

- Ramp controllers are advised to release the aircraft within ±2 min of Target Off-Block Time (TOBT)
- Measured time between TOBT and Actual Off-Block Time (AOBT)
- Ramp controllers tend to pushback aircraft earlier than TOBT