

Investigation and Support of Integration of Departure Metering Concepts into Surface Capabilities

Project 16

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- Airport surface congestion leads to increased taxi times, fuel burn and emissions



- Potential to mitigate impacts through surface congestion management
 - Critical element of evolving surface traffic management tools
 - Needs to be effectively integrated into “gate-to-gate” traffic management, e.g. “3T integration” of Traffic Flow Management System (TFMS), Time-Based Flow Management (TBFM), and Terminal Flight Data Manager (TFDM)

- Leverage experience on departure metering algorithm development, simulation and field test to:
 - Coordinate with related FAA & NASA programs
 - NASA ATD-2 activities at Charlotte Douglas Airport (CLT)
 - Multi-phase field demos starting this Fall to demonstrate integrated surface/terminal/en route concepts
 - Terminal Flight Data Manager (TFDM) deployment
 - RTCA NextGen Integrated Working Group Surface team
 - Surface-Collaborative Decision-Making (S-CDM)
 - Explore specific departure metering algorithms to support above activities
 - Investigate effect on departure metering algorithms of incorporation of S-CDM data elements (e.g., Earliest Off Block Time (EOBT) and gate information)

- Outcomes
 - Guidance on operationally-realistic departure metering approaches to inform FAA, NASA and other stakeholders
 - Estimates of potential benefits
 - Insights into implementation barriers and future opportunities
- Practical applications
 - Support of departure metering in S-CDM, TFDM, ATD-2, RTCA
 - Evaluate impact of uncertainty in availability and accuracy of various data elements (e.g., EOBTs, arrival demand, gate assignments, etc.)
 - Impact of increasing planning horizon
 - Site adaptation of departure metering algorithms
 - Evaluate benefits/challenges for different airports/operating environments
 - Handling ramp operations (and mapping spot times to pushback times)

Exploring impact to S-CDM ConOps and estimated benefits of:

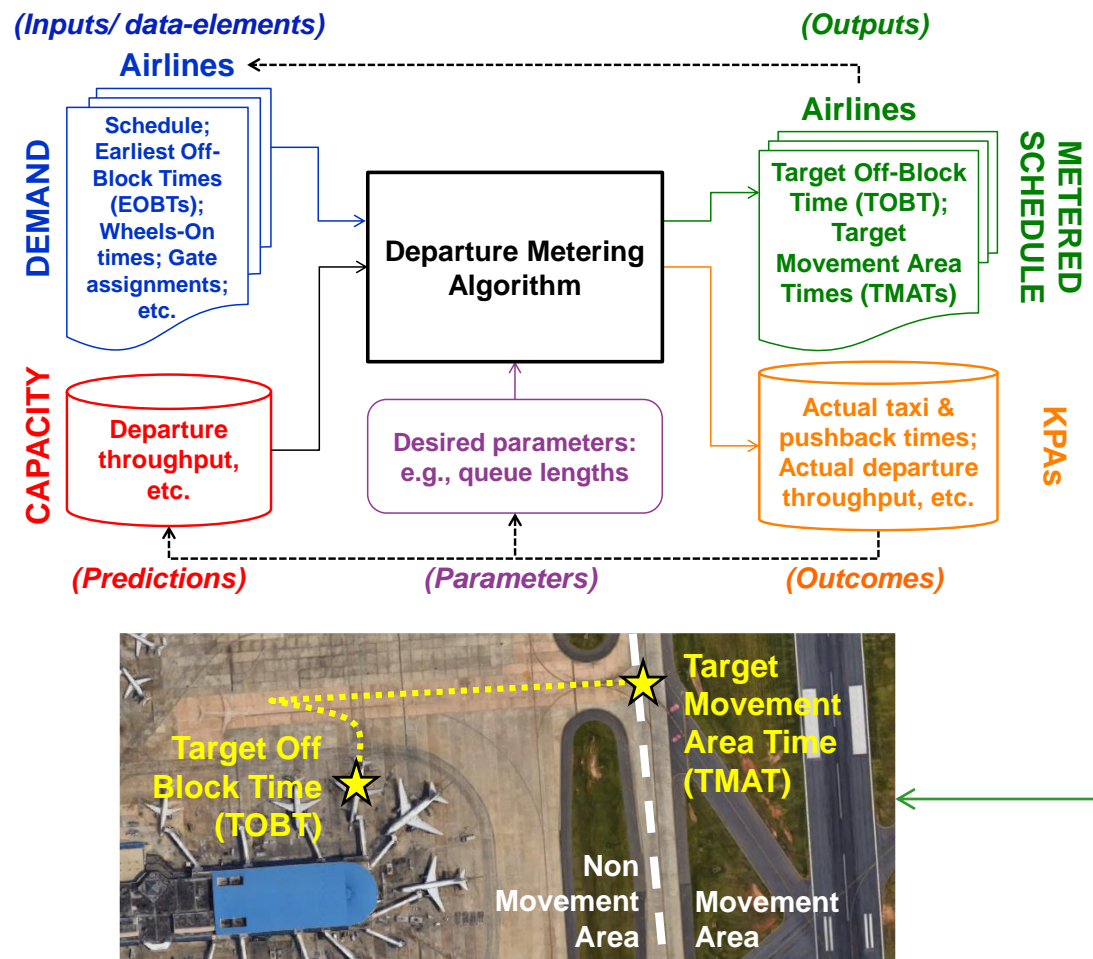
1. Specific departure metering algorithms at different airports

- Characterize airport dynamics with/ without metering
- Conversion of TOBTs to TMATs for different non-movement area complexities

2. Availability and quality of airline-derived data

- E.g., EOBT, Gate information (departures and arrivals), etc.

3. Synthesize findings and implications for relevant programs



- Development & exercising of framework to simulate departure metering within S-CDM (complete)
- Adaptation of framework to CLT operations (on-going)
 - Alignment with NASA's ATD-2 demo, RTCA NIWG Surface goals
 - Spot and Runway Departure Advisor (SARDA)
- Analyzing quality of airline-derived data and impacts to departure metering programs (on-going)
- Synthesize findings and implications for NASA ATD-2 and FAA TFDM activities (on-going)

Recent Accomplishments (1)

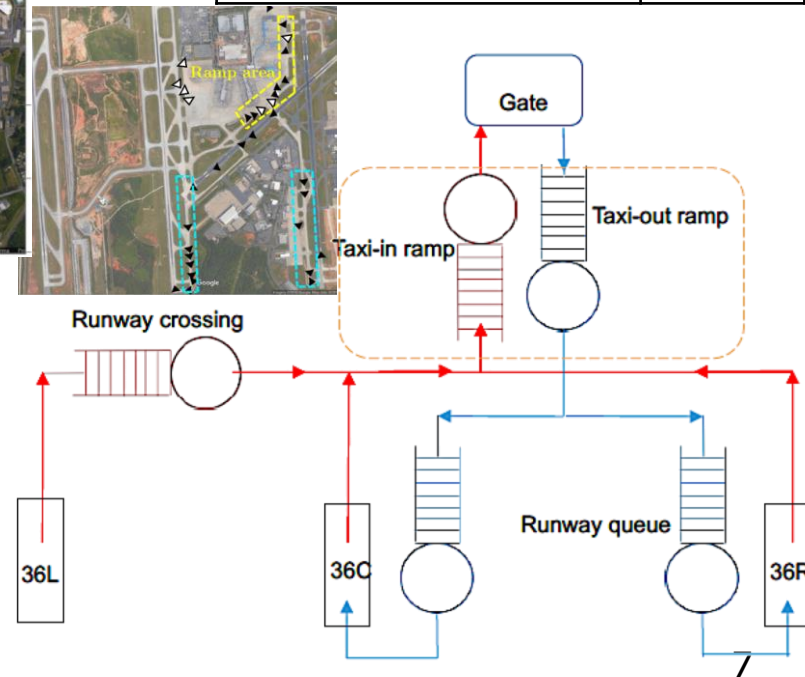
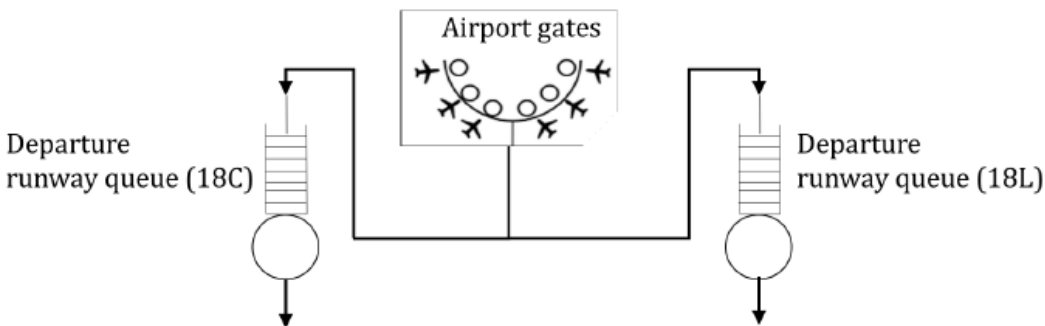
- **Modeling and analysis of CLT operations**

- Consider gate-to-spot and spot-to-runway movements
- Tandem-queue model of CLT North-flow operations
- Queuing model of CLT South-flow

North-flow departures	minutes
Avg. gate to spot time	10.2
Avg. spot to takeoff time	11.0
Avg. total taxi-out time	21.2

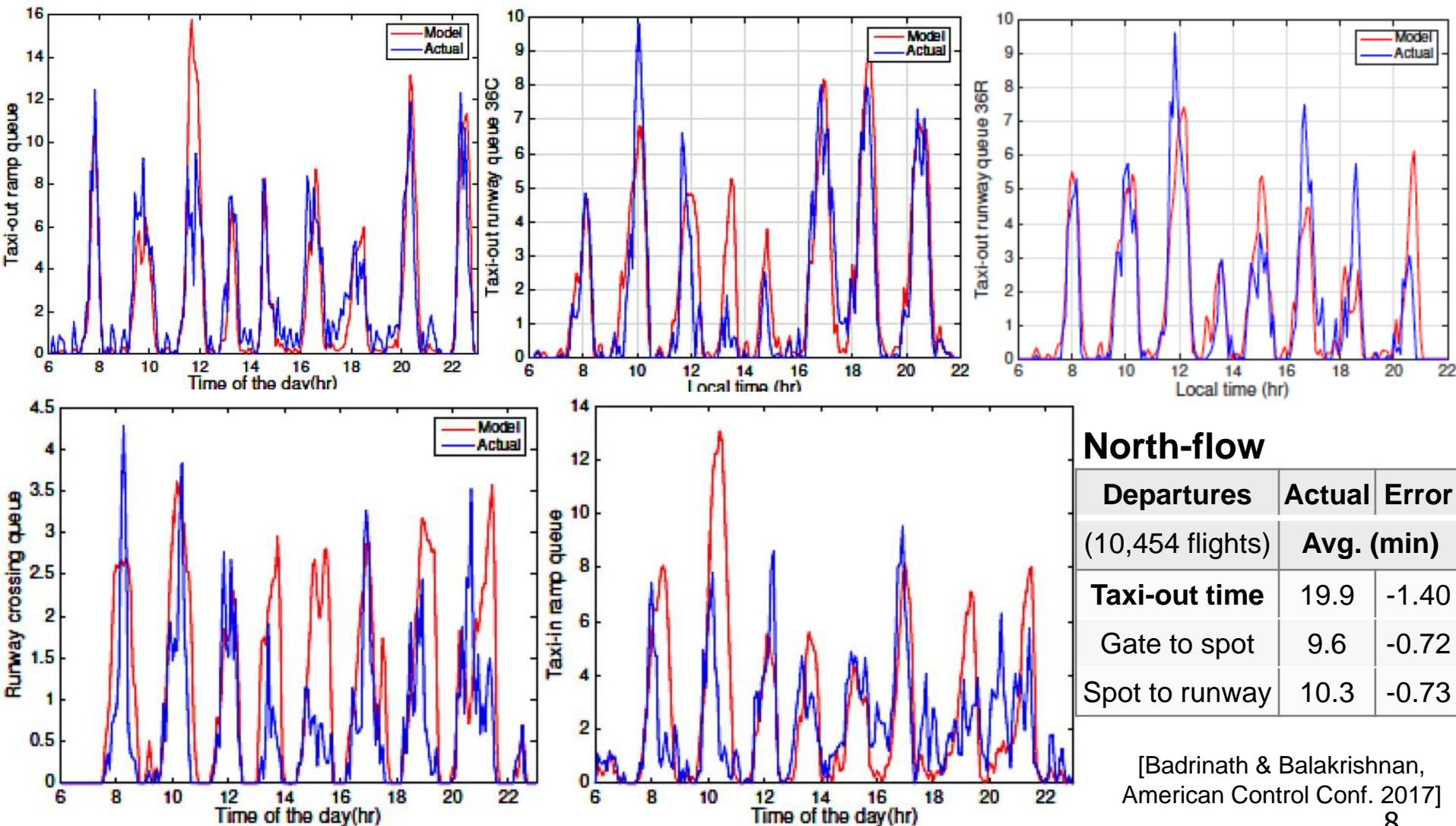


Blue Arrivals Red Departures



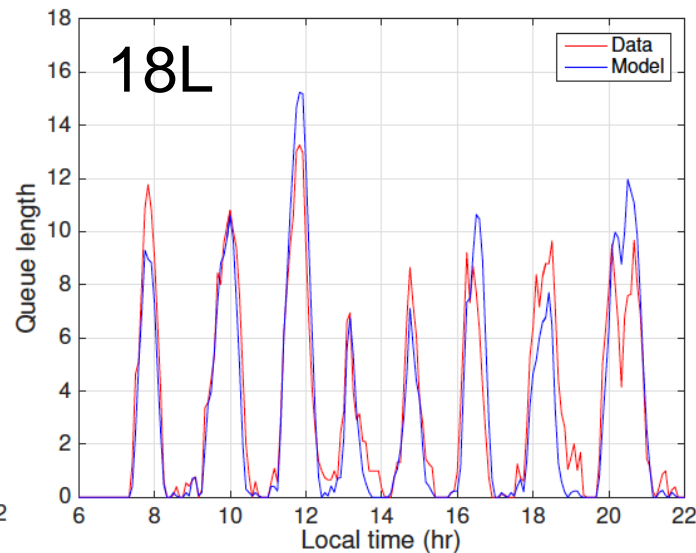
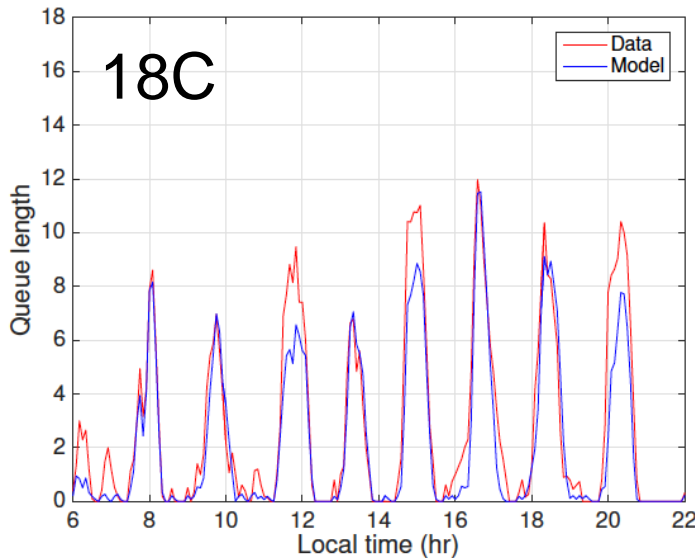
Recent Accomplishments (1)

- Modeling and analysis of CLT operations



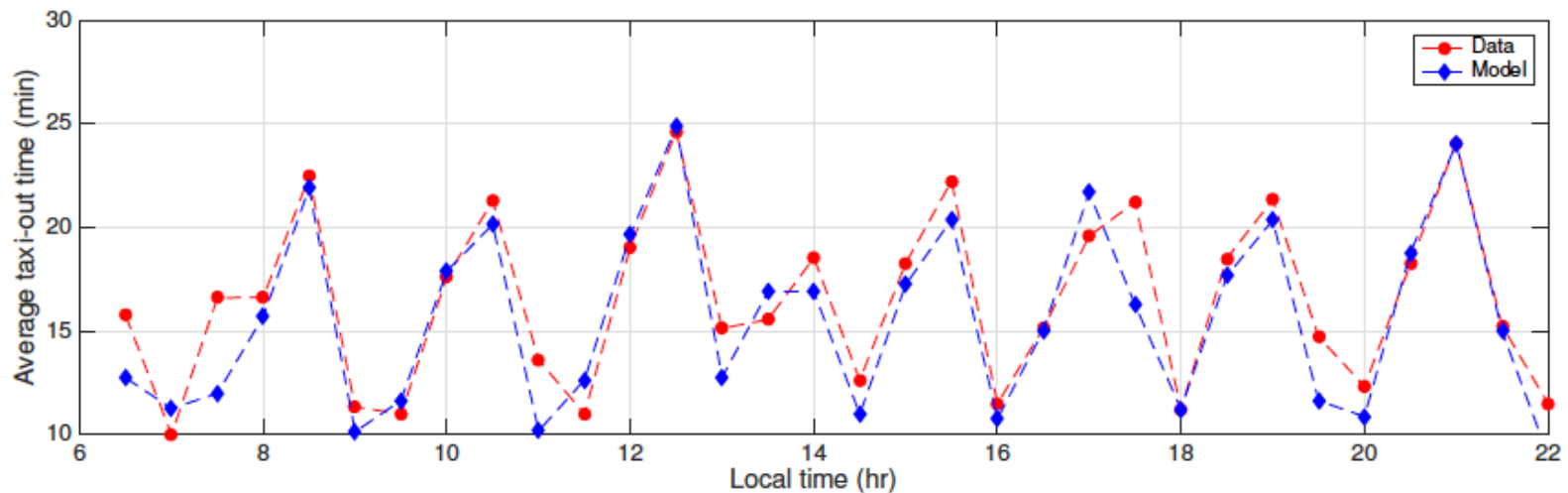
Recent Accomplishments (1)

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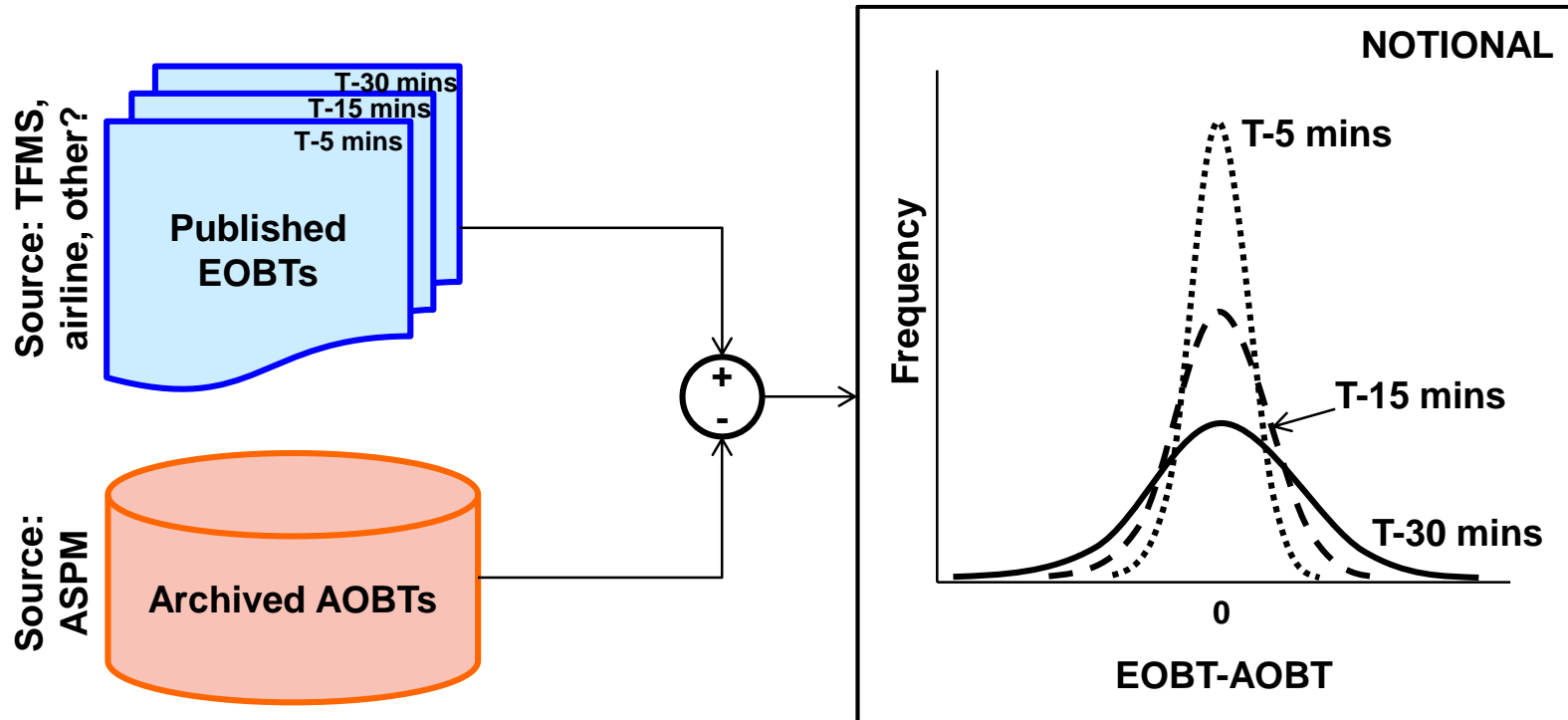
South-flow (30,911 flights)
Taxi-out time prediction
Mean taxi-out time: 18.4 min

Departures	(min)
Mean error	-2.1 min
Mean error	4.9 min
% in ± 5 min	65%



Recent Accomplishments (2)

- **Analyzing impacts of airline-derived data**
 - Airlines beginning to publish Earliest Off-Block Time (EOBT) and gate information
 - Assess EOBT compared to Actual_OBT (AOBT) as a function of:
 - Lookahead time, Airline, Airport (to compare CLT to others), etc.

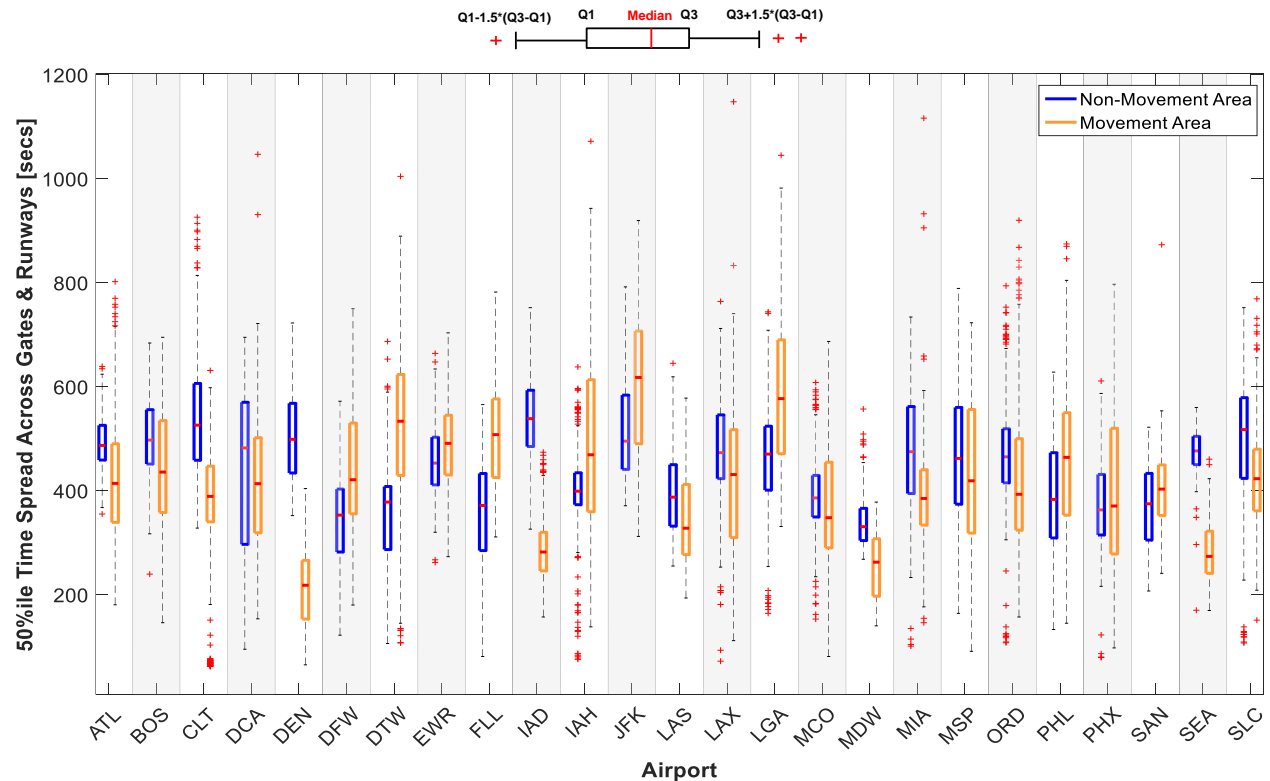


Recent Accomplishments (3)

- **Synthesize findings and implications for relevant programs**
 - Holding regular coordination calls with project leads
 - Adapting program activities to provide highest value output
 - Example: non-movement area/movement area analysis to assist adaptation of ATD-2 CLT activities to other TFDM airports



— NMA/MA boundary



- External
 - S. Badrinath and H. Balakrishnan. “Control of a non-stationary tandem queue model of the airport surface,” American Control Conference, Seattle, WA, May 2017.
 - Ongoing/regular discussions with
 - NASA & American Airlines (regarding the ATD-2 demo at CLT)
 - NASA NRA on costs/benefits mechanisms for ATD-2
 - TFDM Program Office
 - RTCA NextGen Integrated Working Group surface team
 - FAA Surface Office (regarding S-CDM)

- Leverage experience on departure metering algorithm development, simulation and field test to:
 - Coordinate with related FAA & NASA programs
 - Explore specific departure metering algorithms to support above activities
 - Investigate effect on departure metering algorithms of incorporation of S-CDM data elements (e.g., EOBT and gate information)
- Adapting analysis priorities to maximize utility
- Synthesize findings and implications for NASA ATD-2 and FAA TFDM activities

References



- M. Sandberg, T. G. Reynolds, H. Khadilkar and H. Balakrishnan. "Airport Characterization for the Adaptation of Surface Congestion Management Approaches," ATM R&D Seminar, June 2013
- P. McFarlane and H. Balakrishnan. "Optimal Control of Airport Pushbacks in the Presence of Uncertainties," American Control Conference, June 2016
- S. Badrinath and H. Balakrishnan. "Control of a non-stationary tandem queue model of the airport surface," American Control Conference, Seattle, WA, May 2017

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