



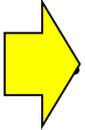
Airspace Technology Demonstration 2 (ATD-2)

Real-time Dashboard, Post Ops, Current Reports, Data Analysis

Rich Copenbarger, Shivanjli Sharma, Al Capps

Dec 14, 2017

- ~~• ATD-2 101 (General Briefing and Demo) May 5th 11AM–1PM EST~~
- ~~• ATD-2 101 (General Briefing and Demo) June 9th 11AM–1PM EST~~
- ~~• ATD-2 201 (Surface/TBFM Scheduling) July 20th 10–11:30 AM EST~~
- ~~• ATD-2 101 (General Briefing and Demo) Aug 3rd 10–Noon EST~~
- ~~• ATD-2 201 (Surface ON time predictions, Runway assignments) Aug 24th 10:30–Noon EST~~
- ~~• ATD-2 301 (Fuser, SWIM Processing & Mediation, Matching) Sept 7th 10:30–Noon EST~~
- ~~• ATD-2 201 (Tactical Surface Metering) Sept 21st 10:30–Noon EST~~
- ~~• ATD-2 201 (Ramp Traffic Tools, Capabilities, Best Practices) Oct 12th 10:30–Noon EST~~
- ~~• ATD-2 101 (General Briefing, Field "go-live" status update) Nov 9th 10:30–Noon EST~~



ATD-2 201 (Real-time Dashboard, Post Ops, Current Reports, Data Analysis) Dec 14th 10:30–Noon EST

- ATD-2 201 (Understand & Process ATC Restrictions in the NAS) TBD
- What would like to see here? Send input to Al.Capps@nasa.gov



- Keep broad group of ATD-2 stakeholders informed of progress in an inexpensive and unobtrusive manner
- Demonstrate actual system capability and lessons learned (as opposed to documents/plans)
- Take input from stakeholders that can be used to improve the ATD-2 system, processes and/or outreach
- Identify areas where more detailed discussion is desired/warranted



Go to https://www.aviationsystemsdivision.arc.nasa.gov/research/tactical/atd2_remote_demos.shtml to learn about upcoming ATD-2 remote demos!

ATD-2 Remote Demos

To Join...

1. Go to: <https://ac.arc.nasa.gov/atd2/>
Enter as a guest and type your name. NASA Employees can log-in with their email and password (NDC Credentials).
2. Dial the Telecon Number: **1-844-467-6272, Passcode: 592382#**

Demo Objectives

- Keep broad group of ATD-2 stakeholders informed of progress in an inexpensive and unobtrusive manner
- Demonstrate actual system capability and lessons learned (as opposed to documents/plans)
- Take input from stakeholders that can be used to improve the ATD-2 system, processes and/or outreach
- Identify areas where more detailed discussion is desired/warranted

Schedule

ATD-2 201 (Tactical Surface Metering)	Sept. 21st 10:30–Noon ET
ATD-2 201 (Ramp Traffic Tools, Capabilities, Best Practices)	Oct. 12th 10:30–Noon ET
ATD-2 101 (General Briefing, Field “go-live” status update)	Oct. 26th 10:30–Noon ET
ATD-2 201 (Real-time Dashboard and Post Ops)	Nov. 9th 10:30–Noon ET
ATD-2 201 (Metrics-Baseline, Current Reports, Data Analysis)	Nov. 30th 10:30–Noon ET
ATD-2 201 (Understand & Process ATC Restrictions in the NAS)	Dec. 13th 10:30–Noon ET

- The audio and video from this demo are being recorded



**RECORDING
IN PROGRESS**

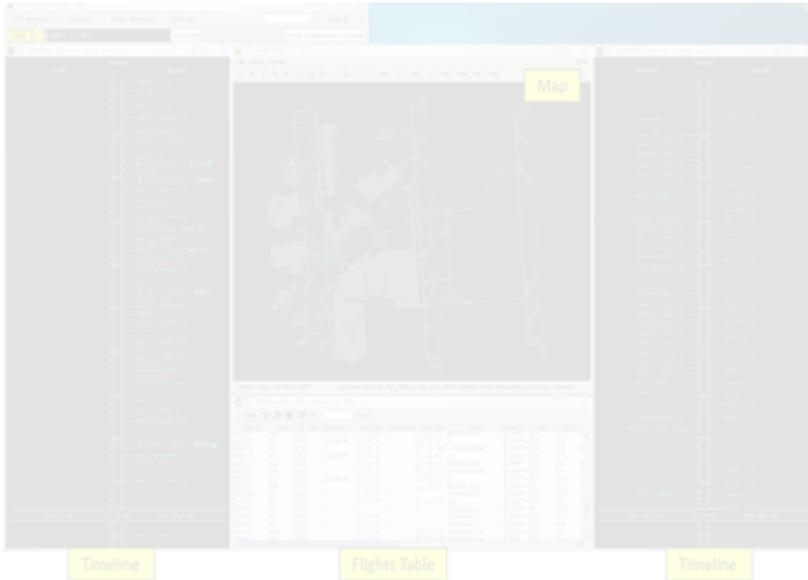


- Overview of DASH (Data Analysis and System Health) for real time metrics
- Current operational reports (DDD – Daily Data Digest)
- Preliminary analysis from Phase 1B and 1C
- Benefits Data Analysis

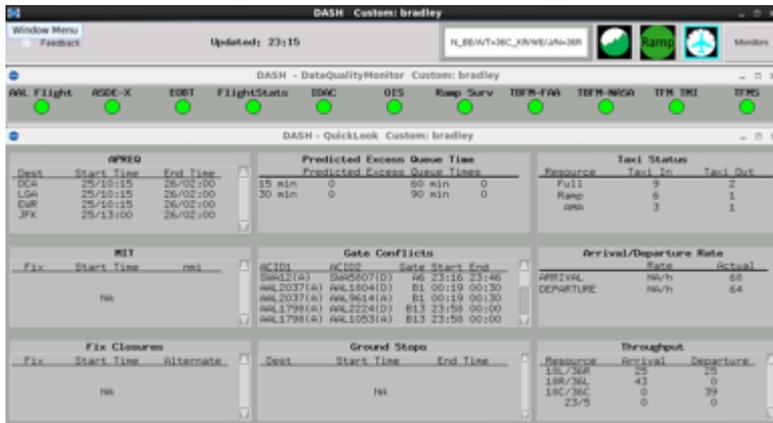
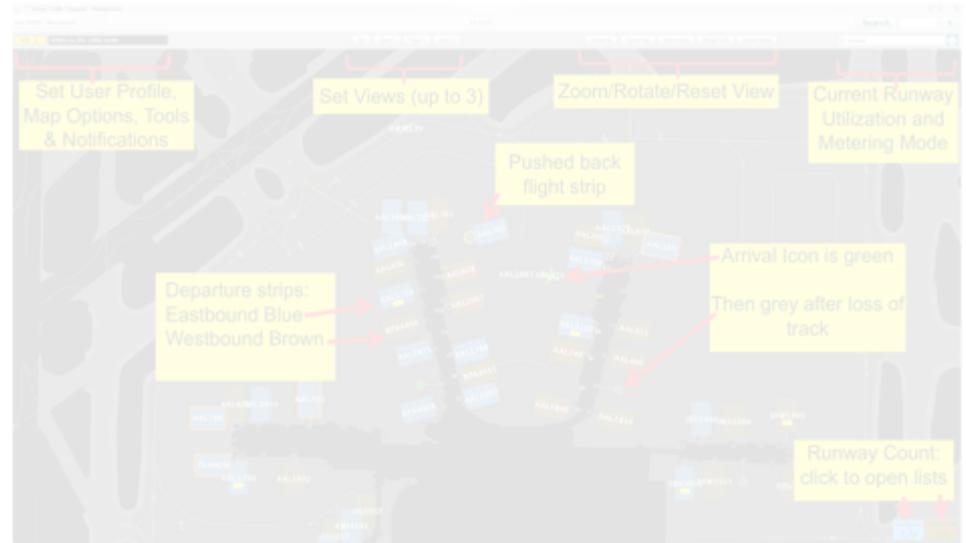


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STBO – Surface Trajectory Based Operations



RTC – Ramp Traffic Console



DASH – Data Analysis and System Health

What If System



Provide a variety of users with common situational awareness and the ability to access metrics computed in real time

- Quick high level check on the “health” of the airport
- Assess traffic levels and delays
- Enable surface metering decisions

Utilizes queries from a database which includes numerous input feeds that support the ATD-2 system, post-operations, and real-time analysis. Evolving to an online tool to expand the scope and pool of users.

DASH is running on every ATD-2 system deployed at CLT as well as on the What If systems

- This enables views of real time metrics for operational use as well as on potential scenarios tested on the What If Systems



DASH Custom: bradley
_ □ ×

Window Menu
Updated: 23:15
N_BE/A/T=36C_KR/WE/J/N=36R

Monitors

DASH - DataQualityMonitor Custom: bradley
_ □ ×

AAL Flight
ASDE-X
EOBT
FlightStats
IDAC
OIS
Ramp Surv
TBFM-FAA
TBFM-NASA
TFM TMI
TFMS

DASH - QuickLook Custom: bradley
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APREQ			Predicted Excess Queue Time				Taxi Status		
Dest	Start Time	End Time	Predicted Excess		Queue Times		Resource	Taxi In	Taxi Out
DCA	25/10:15	26/02:00	15 min	0	60 min	0	Full	9	2
LGA	25/10:15	26/02:00	30 min	0	90 min	0	Ramp	6	1
EWR	25/10:15	26/02:00					AMA	3	1
JFK	25/13:00	26/02:00							

MIT			Gate Conflicts					Arrival/Departure Rate		
Fix	Start Time	nmi	ACID1	ACID2	Gate	Start	End	Rate		Actual
NA			SWA12(A)	SWA5807(D)	A6	23:16	23:46	ARRIVAL	NA/h	68
			AAL2037(A)	AAL1804(D)	B1	00:19	00:30	DEPARTURE	NA/h	64
			AAL2037(A)	AAL9614(A)	B1	00:19	00:30			
			AAL1798(A)	AAL2224(D)	B13	23:58	00:00			
			AAL1798(A)	AAL1053(A)	B13	23:58	00:00			

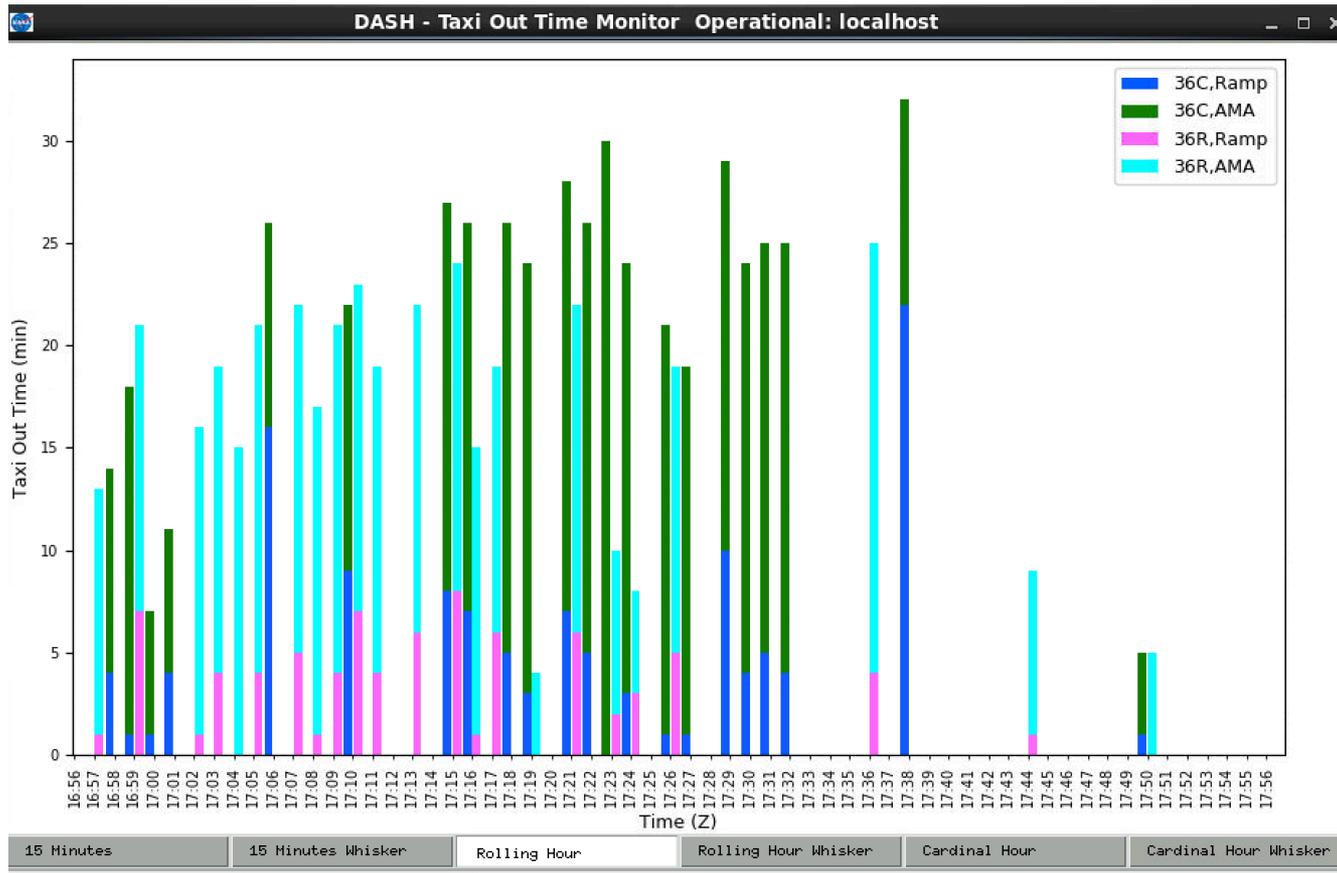
Fix Closures			Ground Stops			Throughput		
Fix	Start Time	Alternate	Dest	Start Time	End Time	Resource	Arrival	Departure
NA						18L/36R	25	25
						18R/36L	43	0
						18C/36C	0	39
						23/5	0	0

DASH Custom: bradley

Feedback Updated: 23:12

N_BE/A/T=36C_KR/WE/J/N=36R

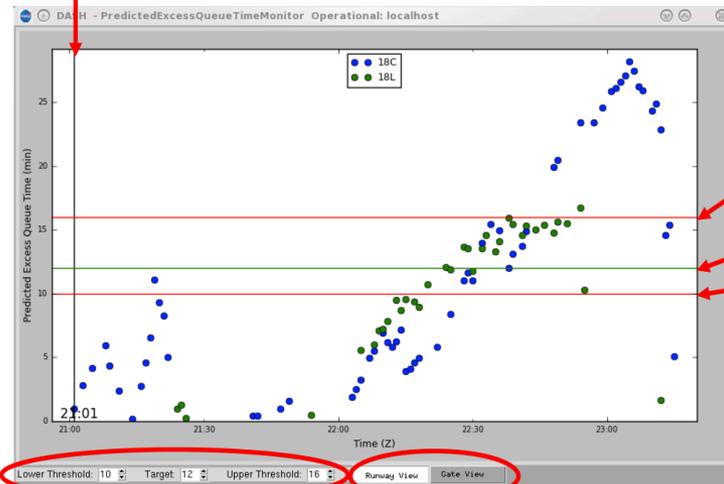
Monitors



- Data Quality Monitor
- Quick Look
- Dep & Arr Monitor
- Dep & Arr By Rwy Direction Monitor
- Dep & Arr By Departure Fix Monitor
- Predicted Excess Queue Times Monitor
- Predicted Excess Queue Times By Rwy Direction Monitor
- Gate Hold Monitor
- Taxi Out Time Monitor
- Taxi In Time Monitor
- Throughput Monitor

Predicted excess queue time monitor relative to the runway

Current Time



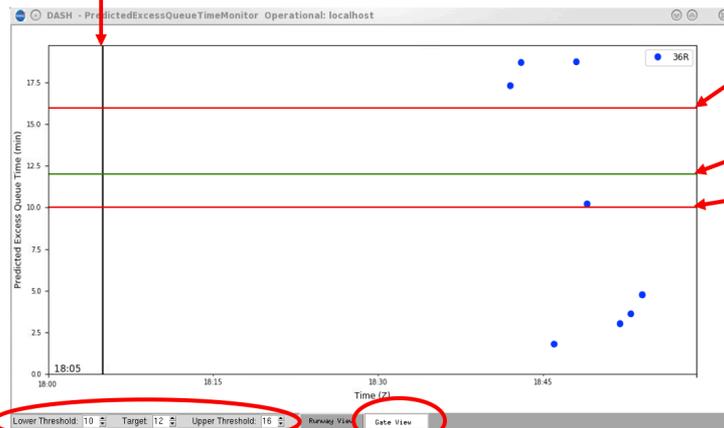
Upper Threshold
Target
Lower Threshold

Enter proposed values for Lower Threshold, Target Queue Length, and Upper Threshold here

Choose Runway View or Gate View here

Predicted excess queue time monitor relative to the gate

Current Time



Upper Threshold
Target
Lower Threshold

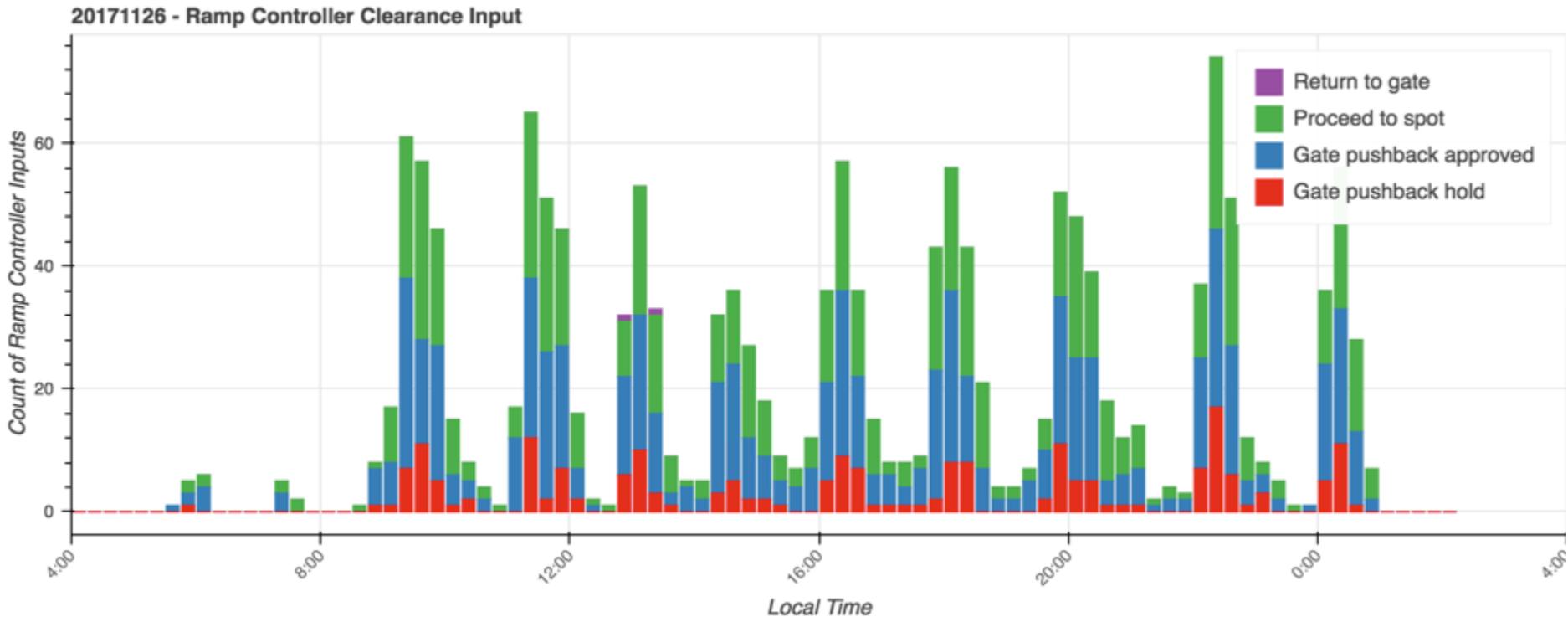
Enter proposed values for Lower Threshold, Target Queue Length, and Upper Threshold here

Gate View selected



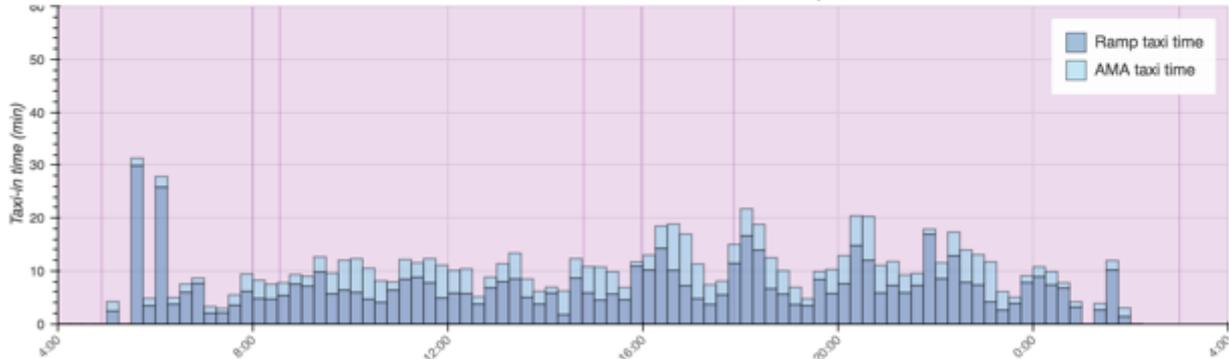
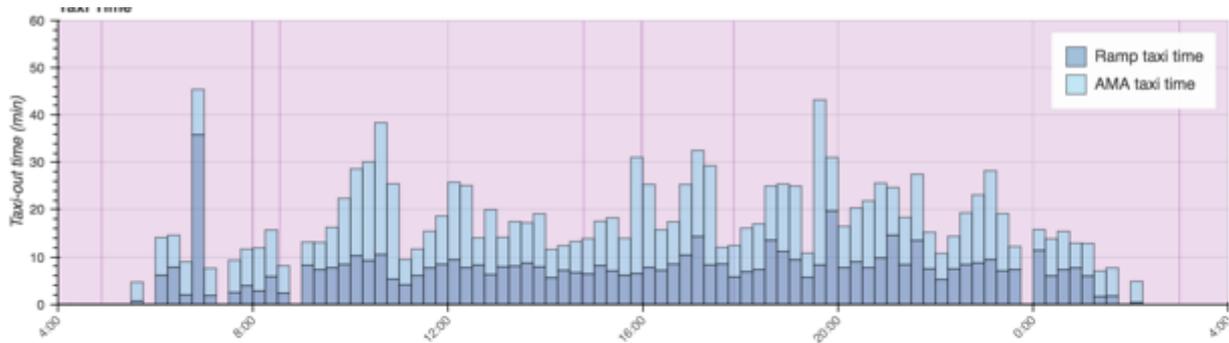
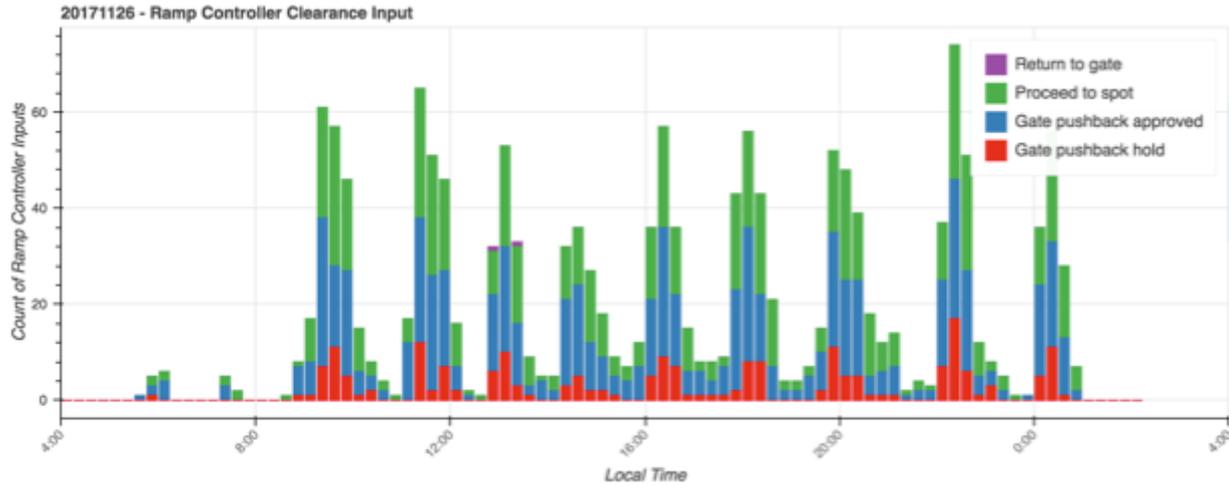
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- DDD is a daily email that is shared with users and field demo partners containing information regarding the previous day's operations in both numerical and graphical views
 - Information includes flow configuration, bank start/stop times, taxi in/out times, controlled flight information, system usage metrics, and surface metering metrics



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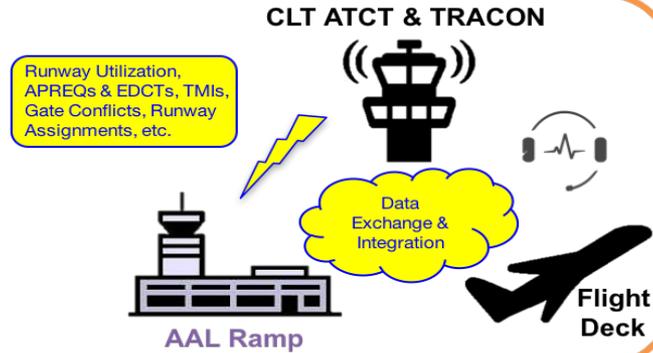
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1A

Phase 1A: Data Exchange & Integration

Target Date: Sep 29, 2017

Description: The focus of this phase is on use of the ATD-2 system for all data exchange features between ATCT and the ramp as part of daily operations. It starts with the second bank of the day.

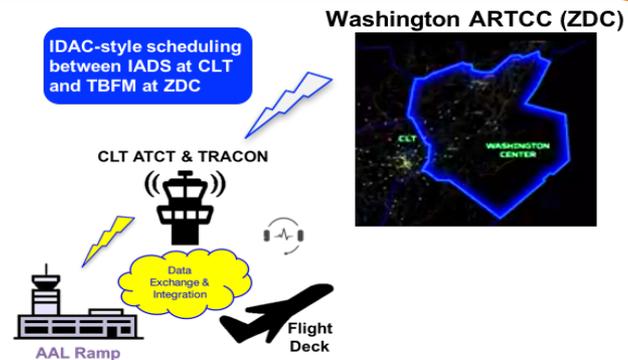


1B

Phase 1B: IDAC Style APREQ Negotiation with ZDC + Phase 1A

Target Date: Oct 26, 2017

Description: The focus of this phase is on use of the ATD-2 system for IDAC style electronic negotiation with ZDC for APREQ/CFR departure scheduling and expanded data exchange beyond bank two.

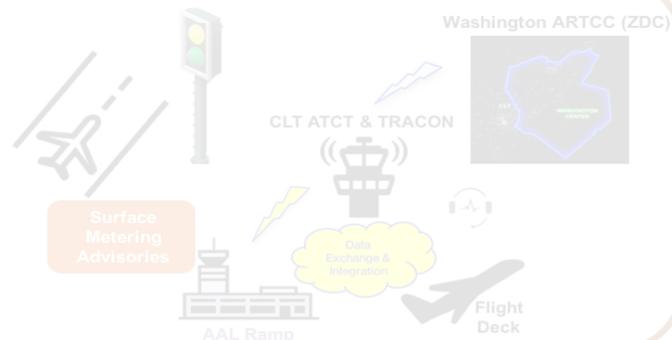


1C

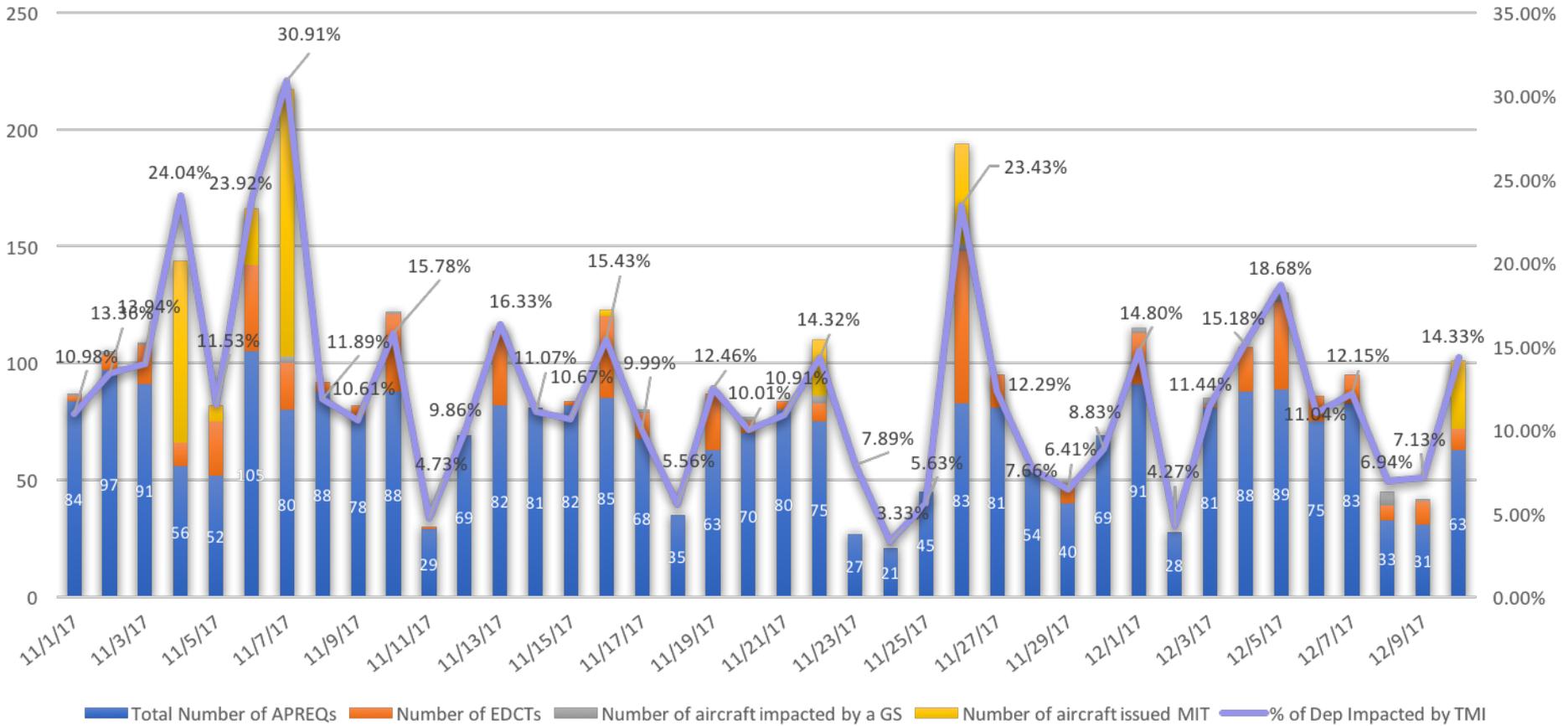
Phase 1C: Surface Metering + Phase 1A & 1B

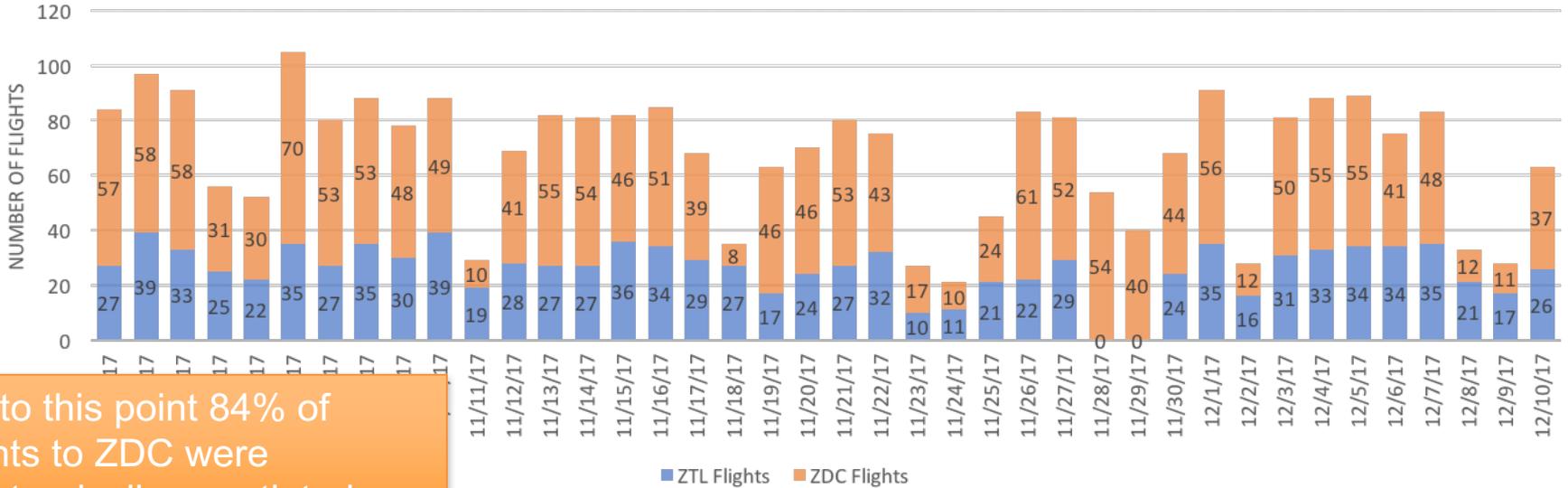
Target Date: Nov 29, 2017

Description: The focus of this phase is on use of the ATD-2 system for all data exchange features during daily operations and utilization of surface departure metering during bank two.



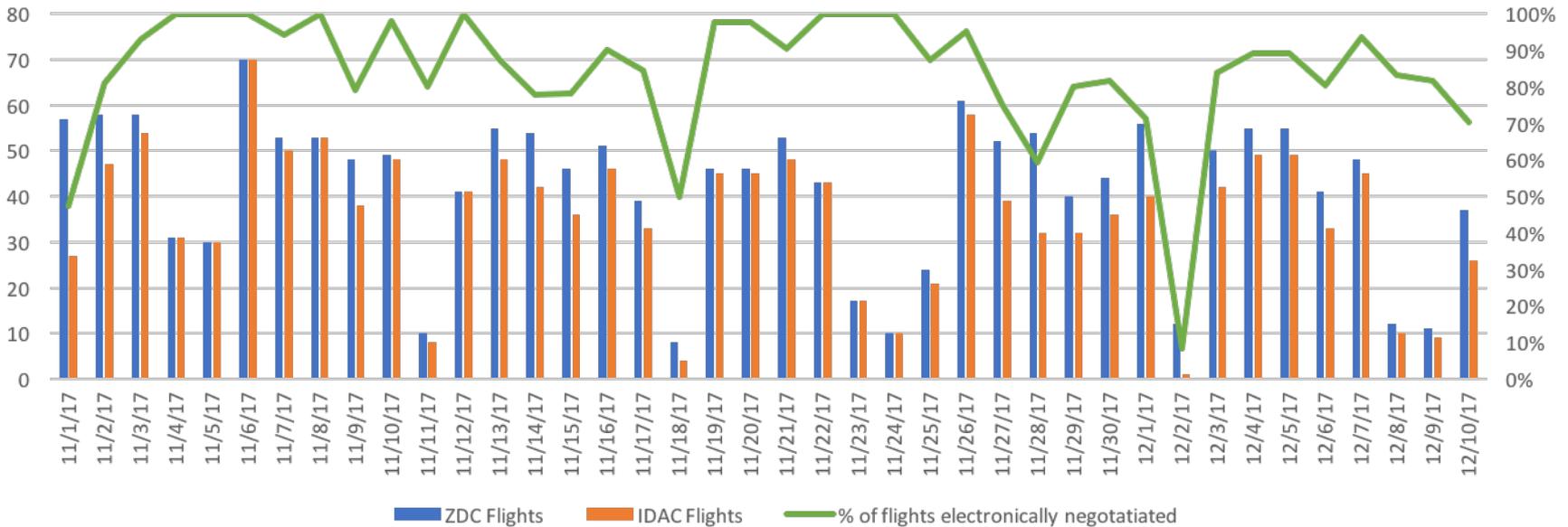
Number of Departures Impacted by TMIs





Up to this point 84% of flights to ZDC were electronically negotiated

APREQ Flights Through ZDC Electronically Negotiated

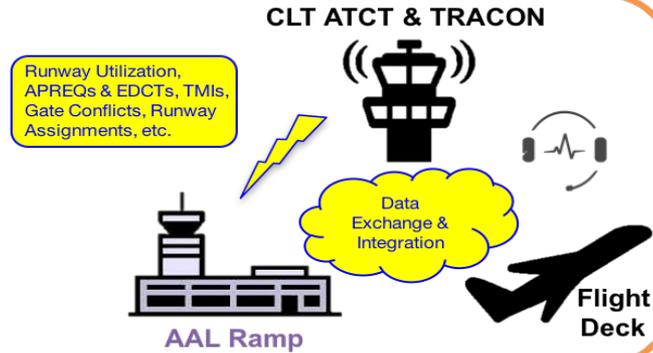


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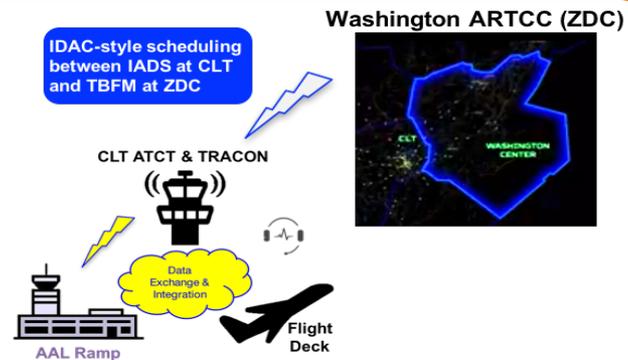


1B

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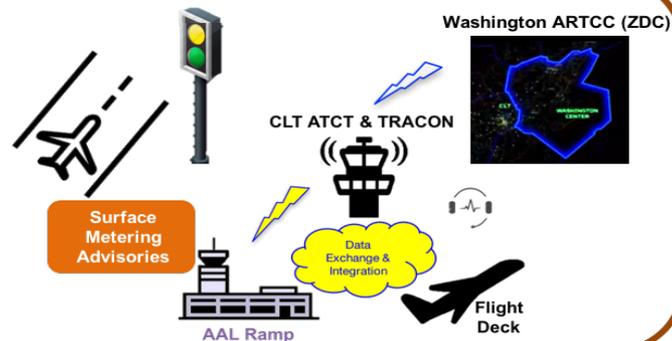


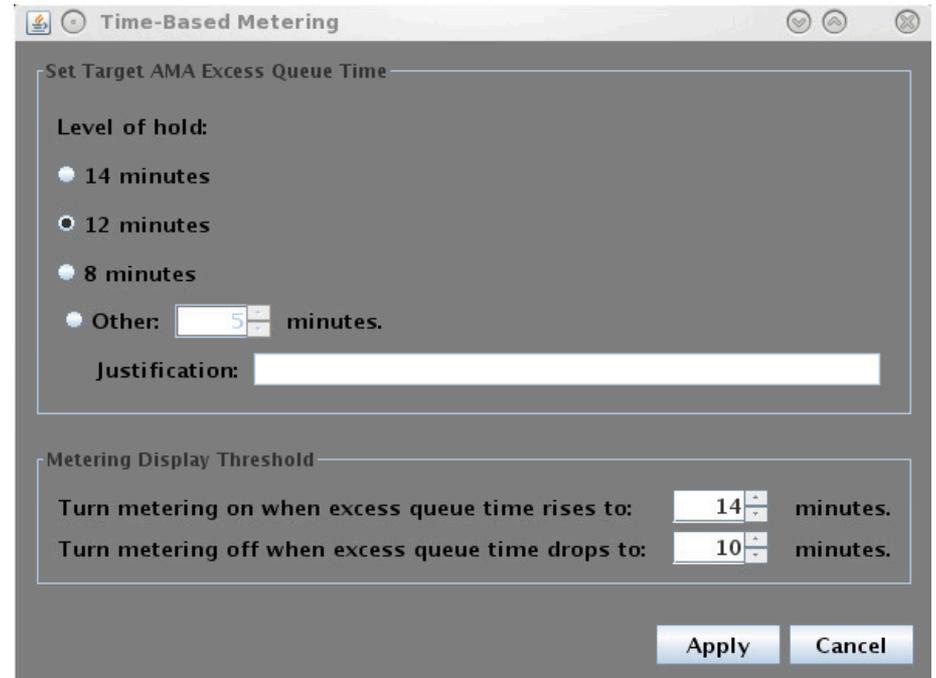
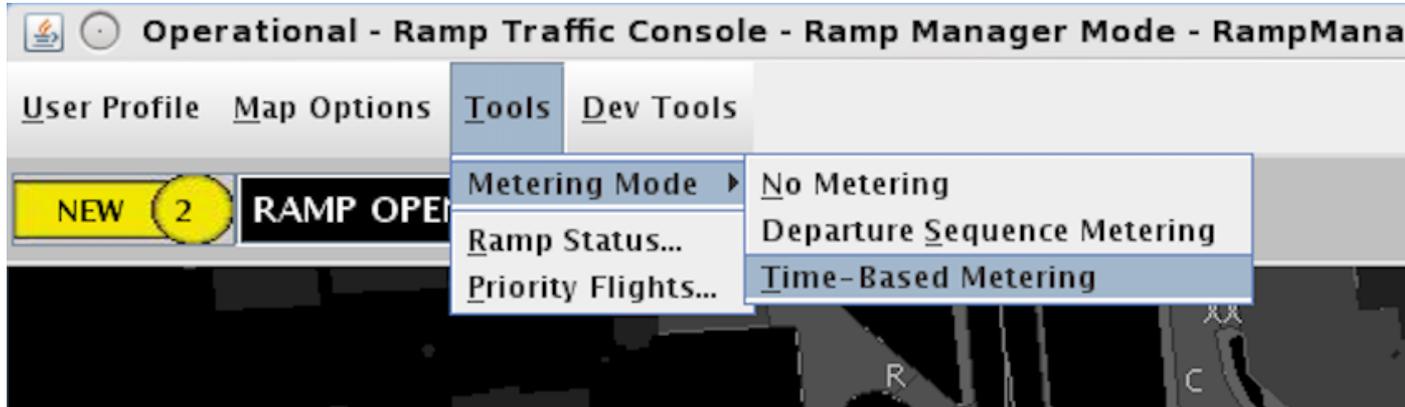
1C

Phase 1C: Surface Metering + Phase 1A & 1B

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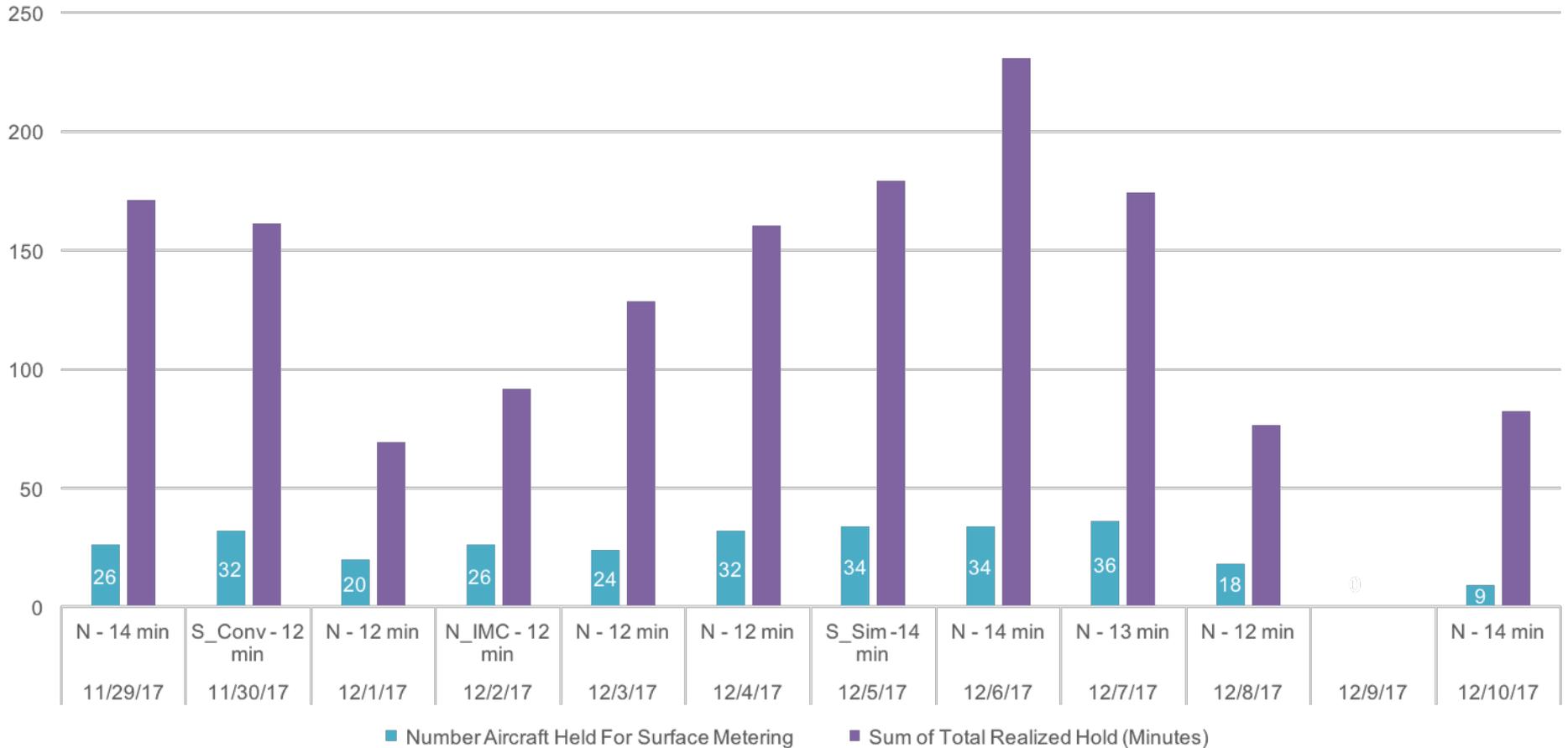




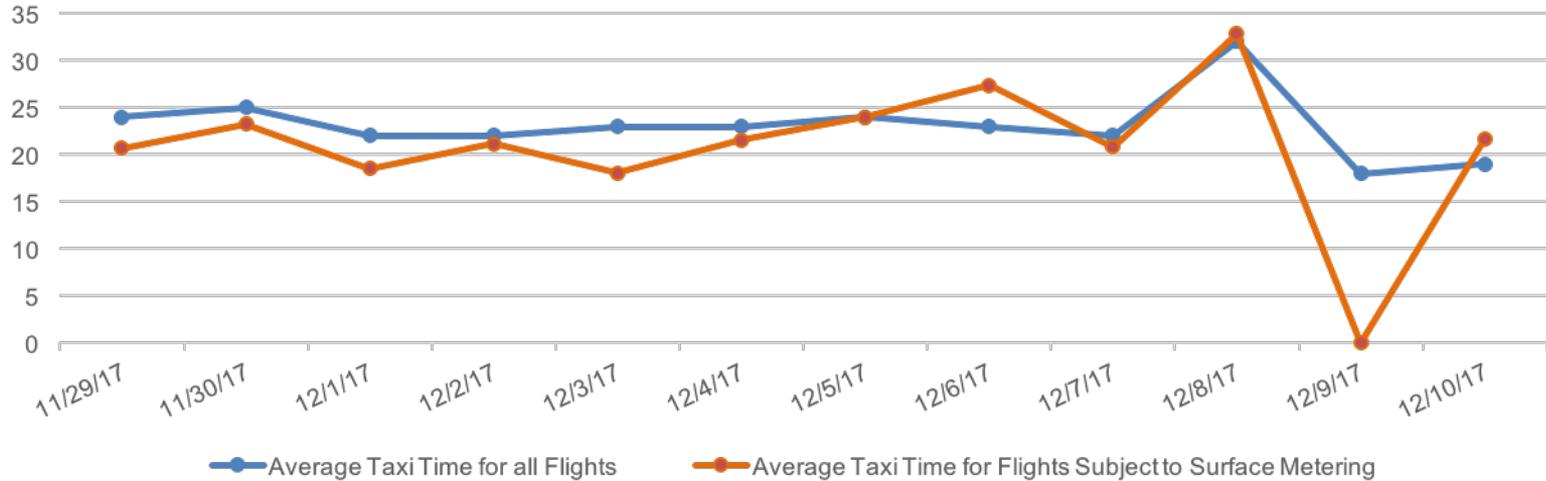


When a flight is put on hold AND metering is on, and the flight is not a controlled FAA flight, it is counted as surface metering. Internationals are exempt. FAA controlled flights (EDCTs and APREQs) are exempt.

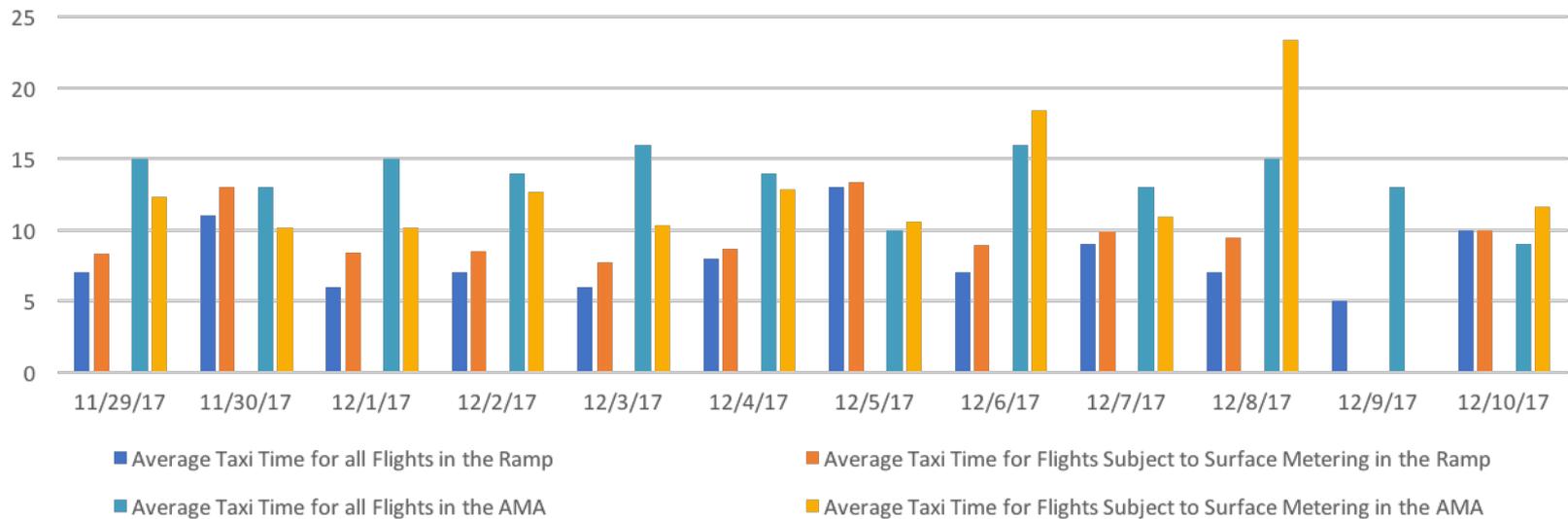
DMP Summary Since the Start of Phase 1C



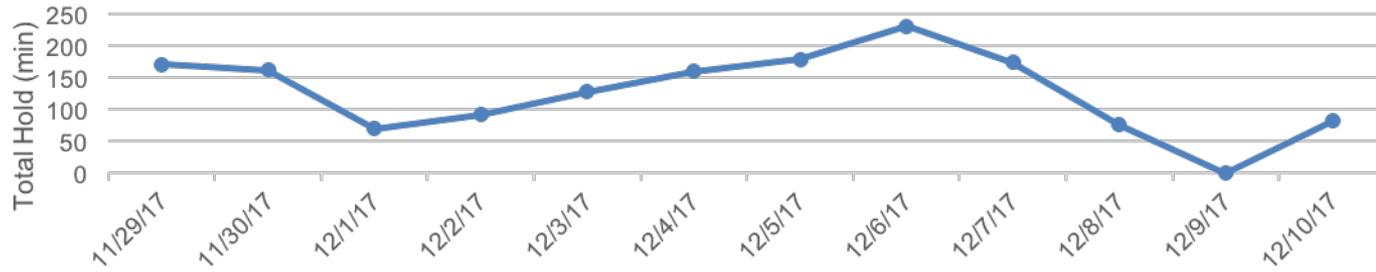
Average Taxi Time



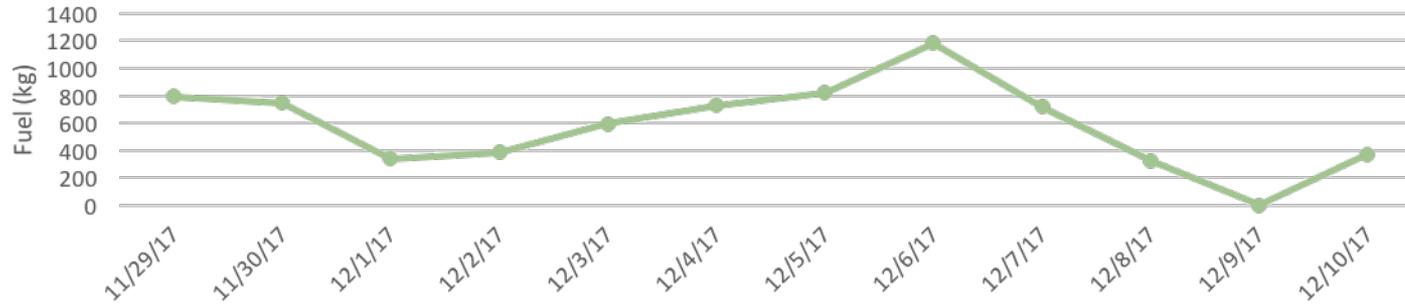
Average Taxi Time in the Ramp and AMA



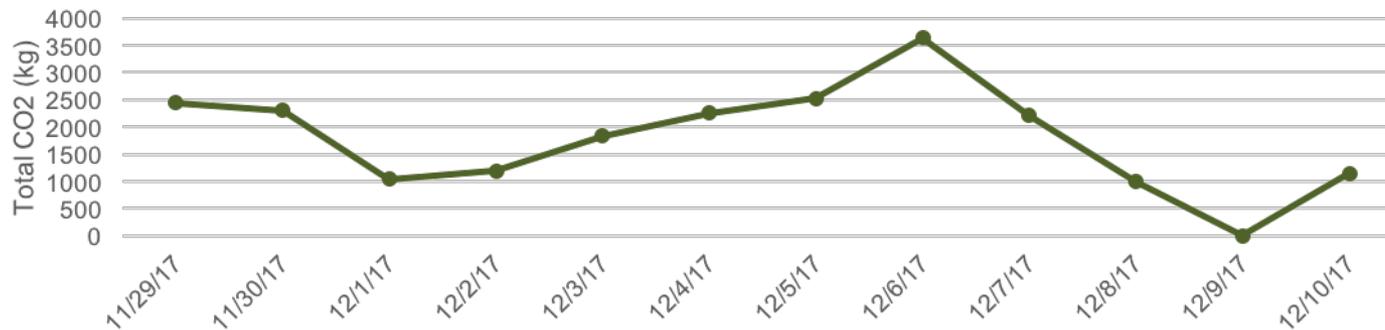
Sum of Total Realized Hold (Minutes)



Total Fuel Saved



Total CO2 Saved





- Overview of DASH (Data Analysis and System Health) for real time metrics
- Current operational reports (DDD – Daily Data Digest)
- Preliminary analysis from Phase 1B and 1C
- **Benefits Data Analysis**



- Benefit objectives
- Benefit metrics
- Data analysis approach
- Sample results from Phase 1A/B/C

GOAL: ATD-2 will improve the predictability and the operational efficiency of the air traffic system through the enhancement, development and integration of the nation's most advanced and sophisticated arrival, departure and surface prediction, scheduling and management systems.

- **Efficiency:** Reduce aircraft movement times and fuel burn
 - Reduce departure queue time by holding flights at gates to minimize congestion and meet TMI constraints
 - Reduce tactical maneuvering during taxi and climb, leading to reduced controller and pilot workload
- **Predictability:** Reduce the variability of aircraft movement times
 - Improve flight predictions and traffic-demand forecasts, leading to more informed decision making
 - Reduce flight-time uncertainty, potentially leading to reduced Scheduled Block Times
- **Throughput:** Maintain or improve runway and airspace throughput
 - Schedule departures in order maximize use of available runway capacity
 - Make better use of available airspace capacity through improved TMI conformance. Together with predictability improvements this can lead to reduced delays and potentially less conservative TMIs.

MEASURES OF PERFORMANCE (MOPS): Developed for Efficiency, Predictability, Throughput, and Human-Factors benefit categories

Definition & Purpose

- Quantitative measures of system performance and usability
- Intended to validate the anticipated efficiency, predictability, throughput benefits of ATD-2
- Intended to show that ATD-2 is operationally acceptable and valuable to stakeholders

Defining Characteristics

- Streamlined set of metrics that can be tracked over each simulation and field demonstration
- Observable and repeatable metrics suitable for collection and computation in real time (or near real time)
- Include a number of Key Performance Parameters (KPPs) intended to track overall project success

MOP	Definition	KPP	Components	Purpose
Taxi-Out Time and Fuel	Transit time and fuel burn from OUT to OFF	Y	<ul style="list-style-type: none"> Ramp taxi-out time/fuel AMA taxi-out time/fuel 	Show decrease in mean taxi-out time and fuel burn with ATD-2
Departure Time Allocation	Departure time taken at gate (or other locations with engines stopped) versus taxi	N	<ul style="list-style-type: none"> Gate time Taxi-out time 	Show more efficient time allocation at gate vs during taxi with ATD-2
Departure Queue Size	Number of aircraft queued for takeoff for a given runway	N	<ul style="list-style-type: none"> At OUT At SPOT 	Show a reduction in mean queue size with ATD-2
Taxi-In Time and Fuel	Transit time and fuel burn from ON to IN	N	<ul style="list-style-type: none"> AMA taxi-in time/fuel Ramp taxi-in time/fuel 	Show no increase in taxi-in time and fuel burn with ATD-2
On-Time Performance	On-time performance for flights subject to ATD-2 departure metering	Y	<ul style="list-style-type: none"> At destination At wheels-off 	Show that ATD-2 causes no substantive harm to airline on-time arrival performance

MOP	Definition	KPP	Components	Purpose
Departure Transit Time Variance	Variation of transit times from gate to en route stream insertion	Y	<ul style="list-style-type: none"> • Ramp taxi-out variance • AMA tax-out variance • Climb variance 	Show reduction in departure movement uncertainty with ATD-2
Departure Prediction Accuracy	Accuracy of predicted times at key points along departure trajectories	N	<ul style="list-style-type: none"> • Predicted AMA entry • Predicted takeoff time • Predicted departure fix crossing 	Show improved trajectory prediction with ATC and airline data exchange (e.g., EOBT)
Target Time Compliance	Compliance with ATD-2 target times during metering and controlled takeoff times due to TMI	Y	<ul style="list-style-type: none"> • TOBT compliance • CTOT compliance (APREQ times and EDCTs) 	<ul style="list-style-type: none"> • Show ability of operators to comply with ATD-2 pushback advisories • Show improved compliance with TMI takeoff restrictions



MOP	Definition	KPP	Components	Purpose
Departure Throughput	Departure throughput for runways, airport, and departure fixes	Y	<ul style="list-style-type: none"> Runway throughput Airport throughput Departure fix throughput 	Show that departure throughput is maintained or improved with ATD-2
Arrival Throughput	Arrival throughput for runways and airport as whole	N	<ul style="list-style-type: none"> Runway throughput Airport throughput 	Show no harm to arrival throughput with ATD-2

MOP	Definition	KPP	Components	Purpose
User Acceptability	Acceptance of ATD-2 automation by stakeholders based on subjective measures	N	<ul style="list-style-type: none"> Ramp user acceptance ATCT user acceptance ARTCC user acceptance 	Show that ATD-2 automation and procedures are acceptable to system users
User Workload	Perceived workload in managing operations with ATD-2	Y	<ul style="list-style-type: none"> Ramp workload ATCT workload ARTCC workload 	Show that perceived (qualitative) workload is maintained or reduced with ATD-2

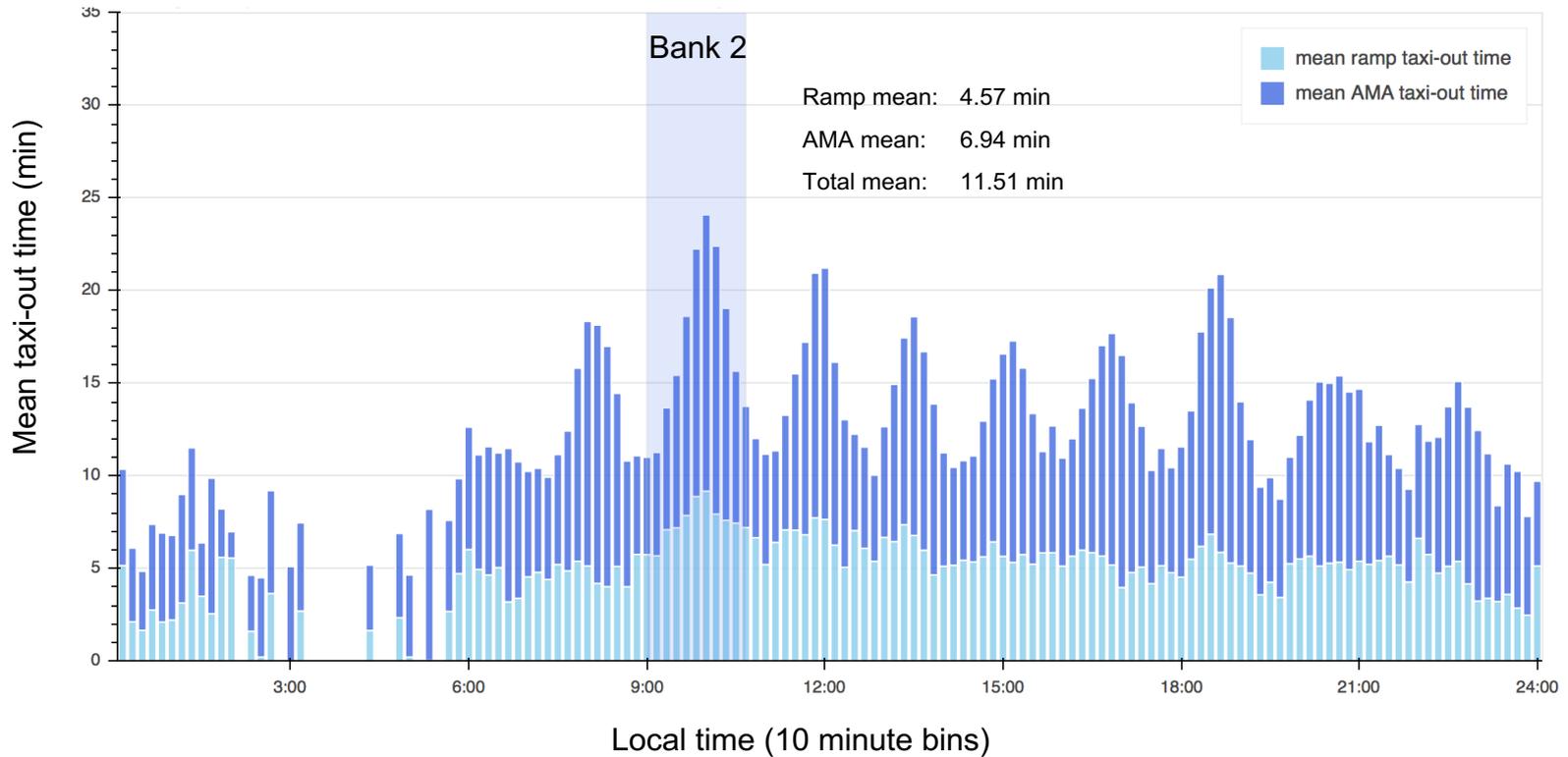


- Baseline operations (pre-ATD-2) data collected and archived since September 2016
- ATD-2 operations data collection started September 29, 2017
- MOPs and other metrics computed daily
- Benefits to be examined by comparing metrics using ATD-2 and baseline data for similar operational conditions and time periods

- Analysis based on Phase 1 field data
 - Phase 1A: Data exchange and integration (Sep 29 – Oct 31)
 - Phase 1B: IDAC style APREQ negotiation with ZDC + Phase 1A (Nov 1 – 28)
 - Phase 1C: Surface metering + Phase 1A & 1B (Nov 29 – present)
- Initial analysis has focused on efficiency metrics:
 - Taxi times for departures and arrivals
 - Excess taxi times relative to unimpeded estimates
 - Fuel and emissions
 - Departure queue size
 - Taxi times and compliance for flights subject to TMs
- Rigorous comparisons with baseline (pre ATD-2) operations are forthcoming

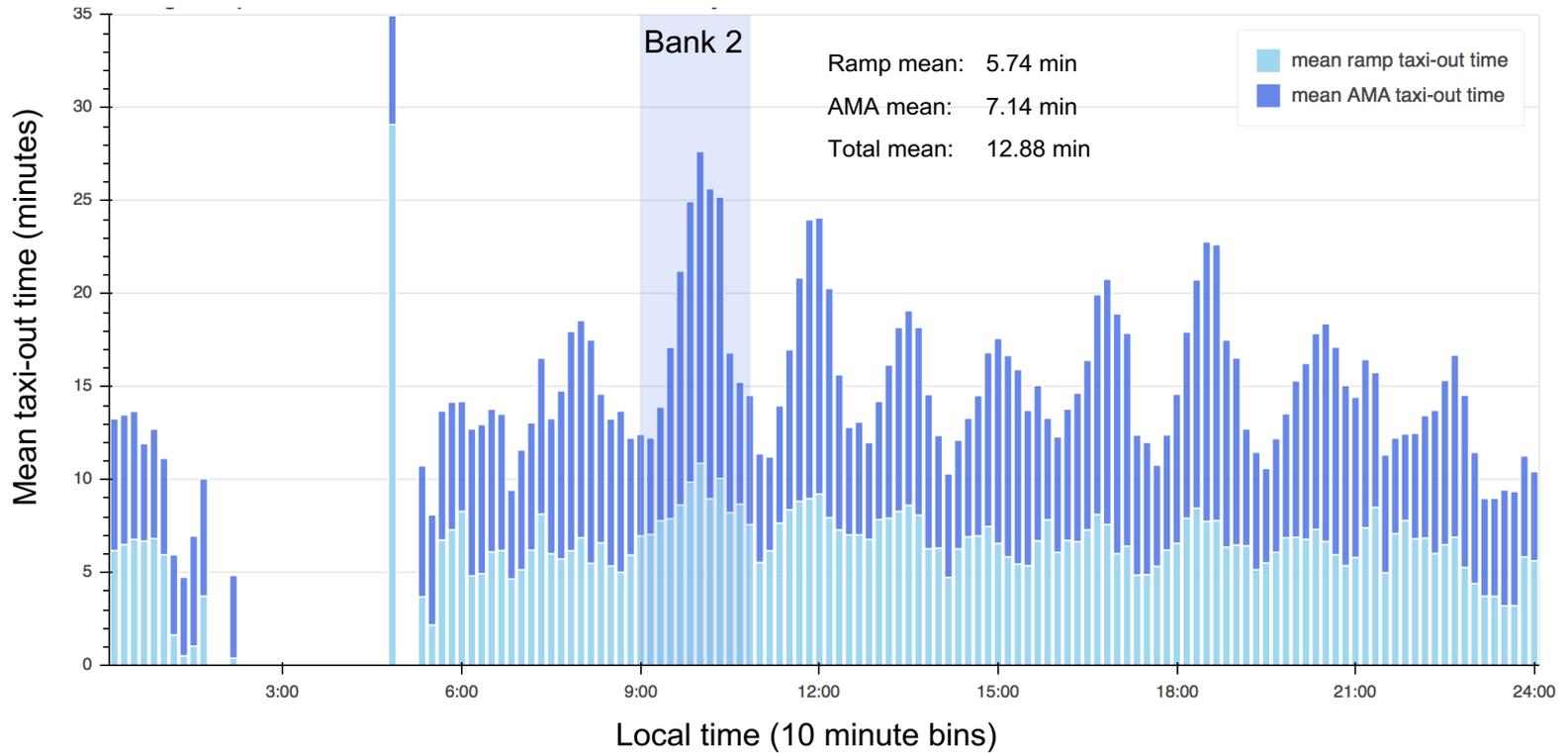
Taxi-out time

Period = Phase 1A; Bank = All; Aircraft = All



Taxi-out time

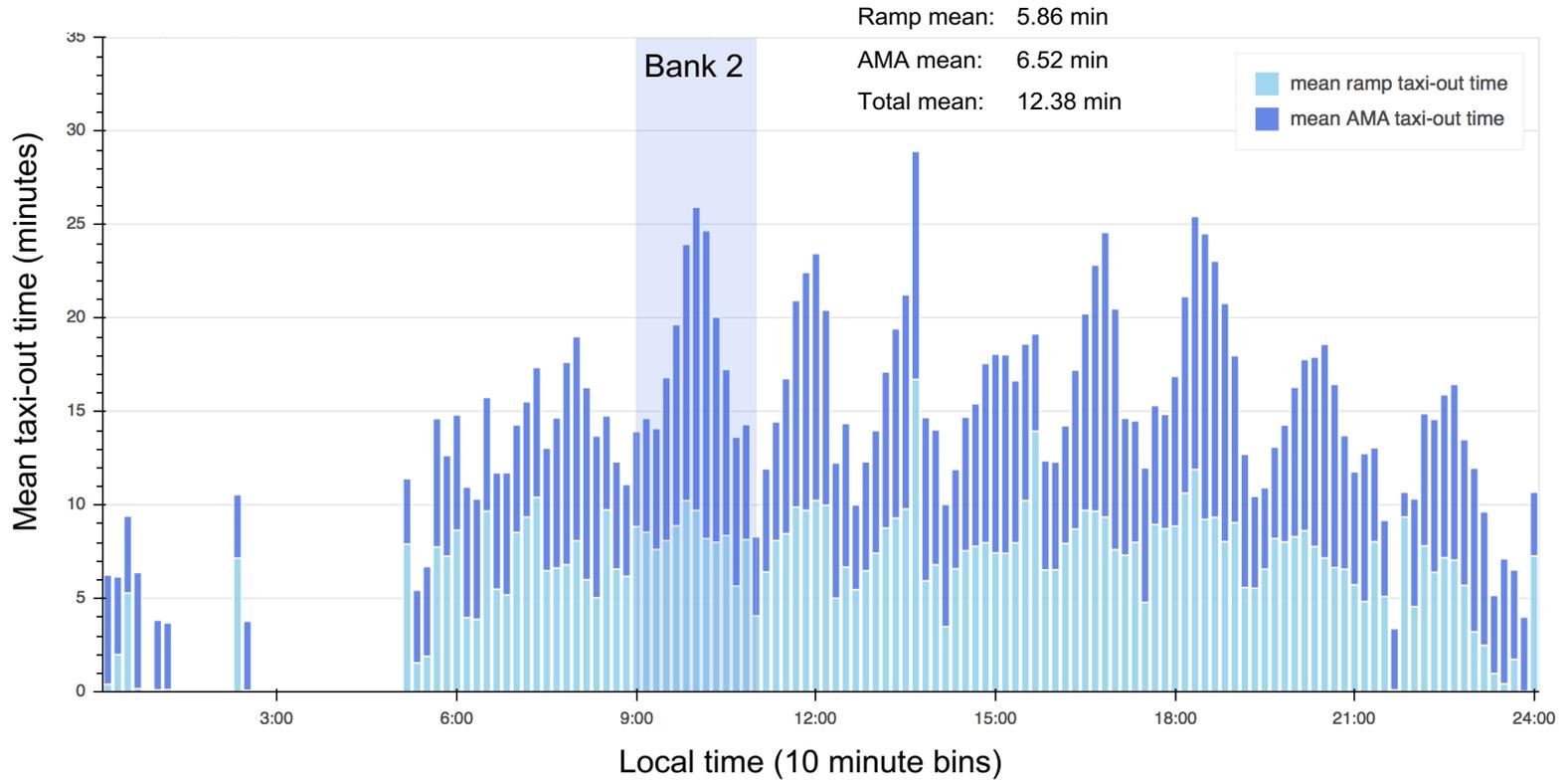
Period = Phase 1B; Bank = All; Aircraft = All



Taxi-out time

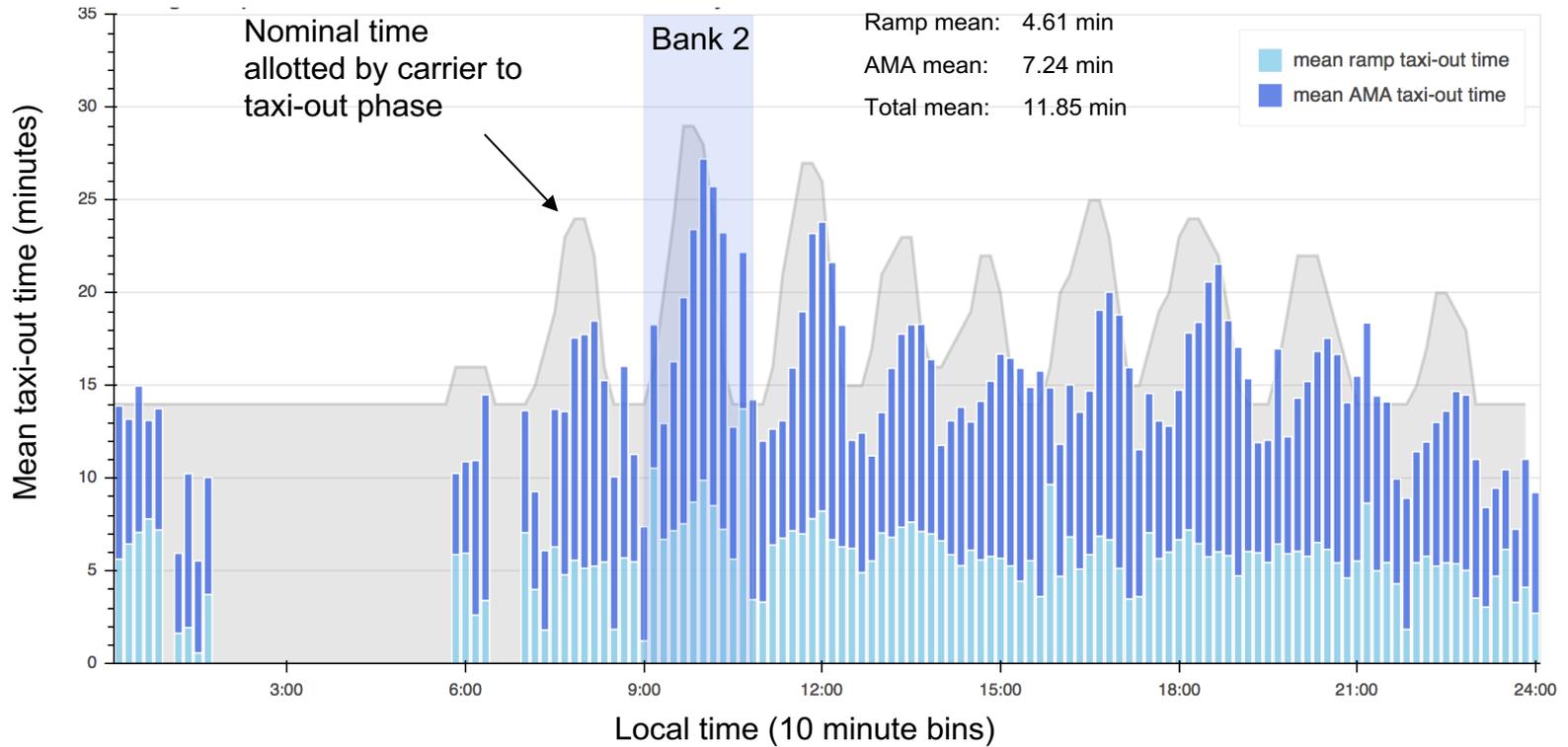


Period = Phase 1C (thru Dec 7); Bank = All; Aircraft = All



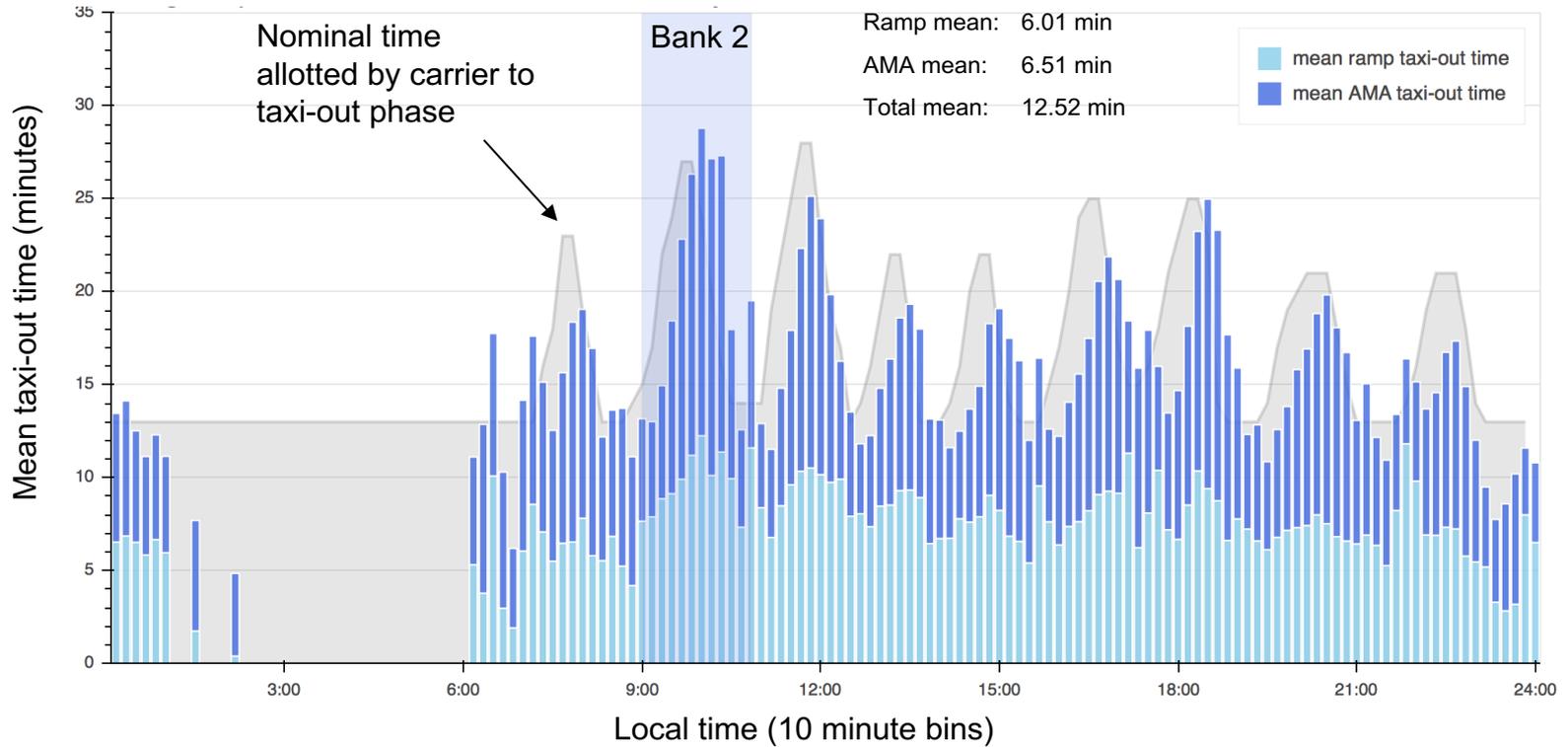
Taxi-out time

Period = Phase 1B; Bank = All; Aircraft = Lead Carrier – Mainline



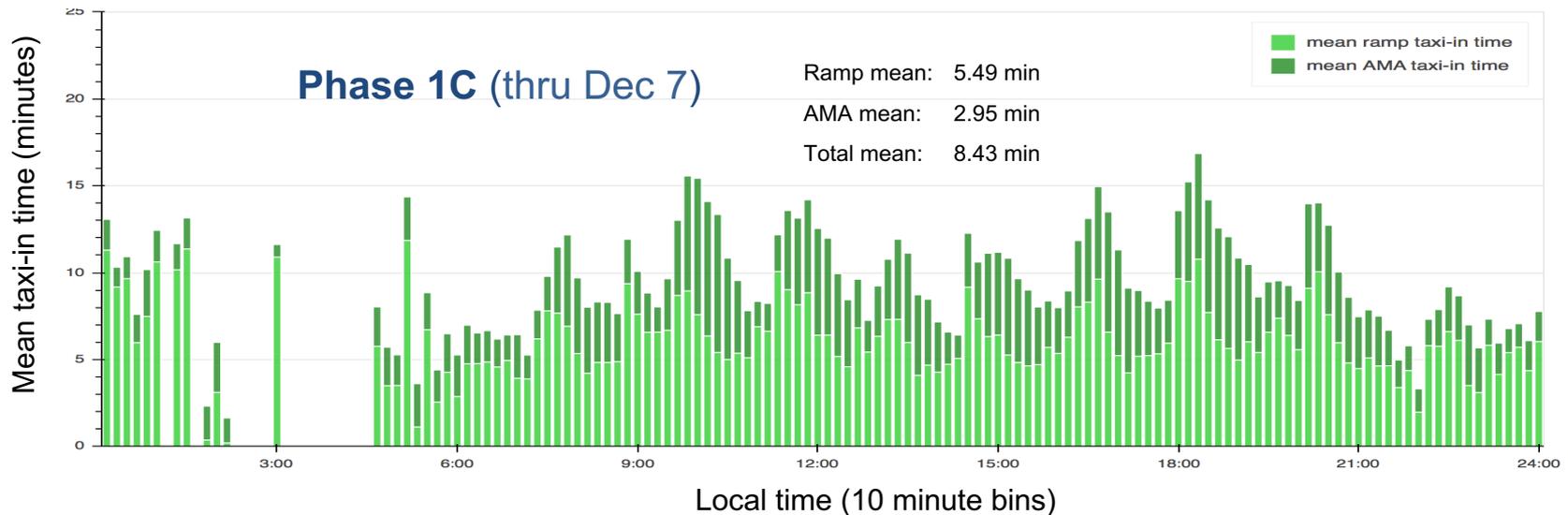
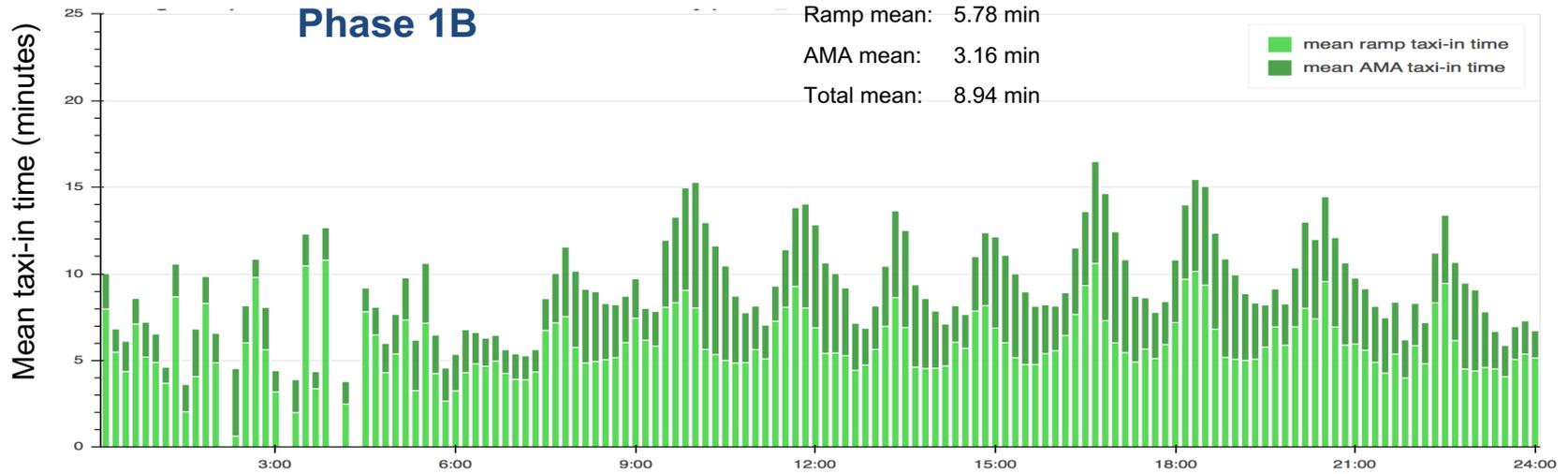
Taxi-out time

Period = Phase 1B; Bank = All; Aircraft = Lead Carrier – Regional

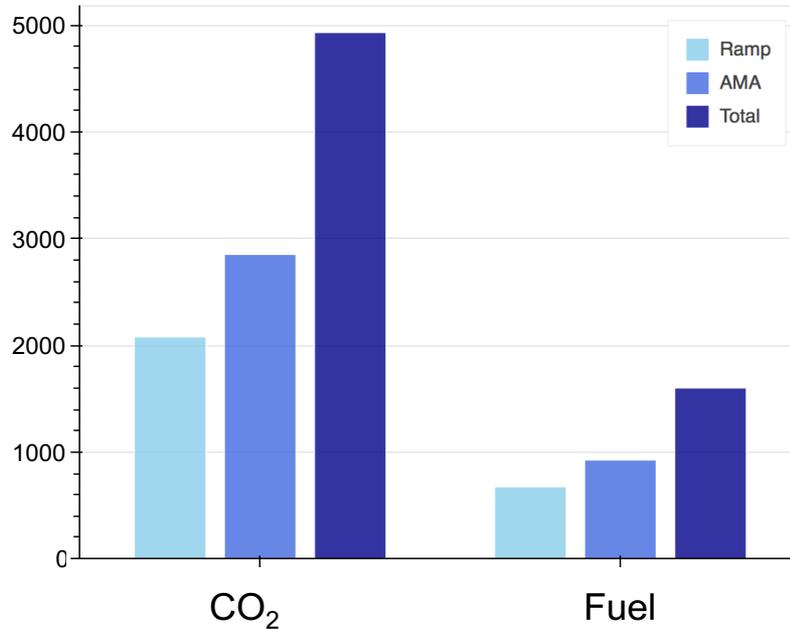


Taxi-in time

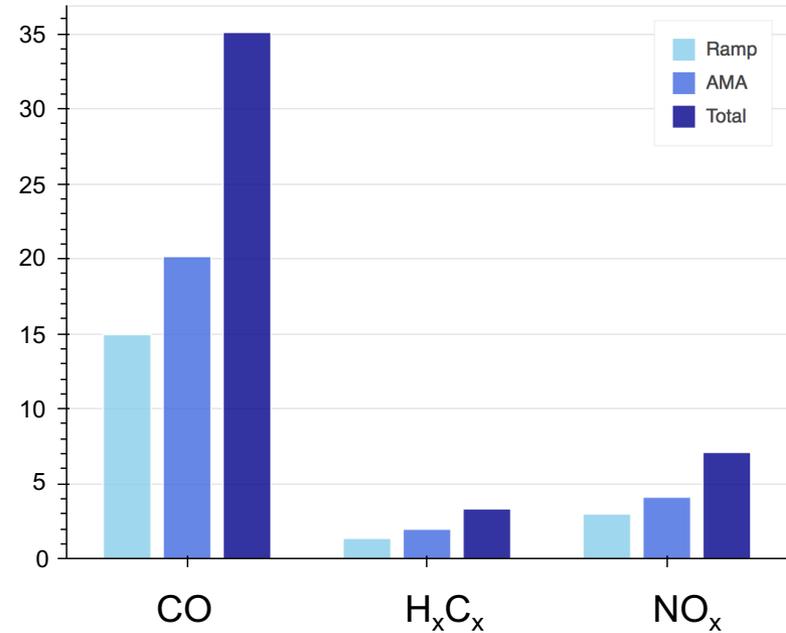
Period = Phase 1B and 1C; Bank = All; Aircraft = All



Aggregate fuel and CO₂, metric tons



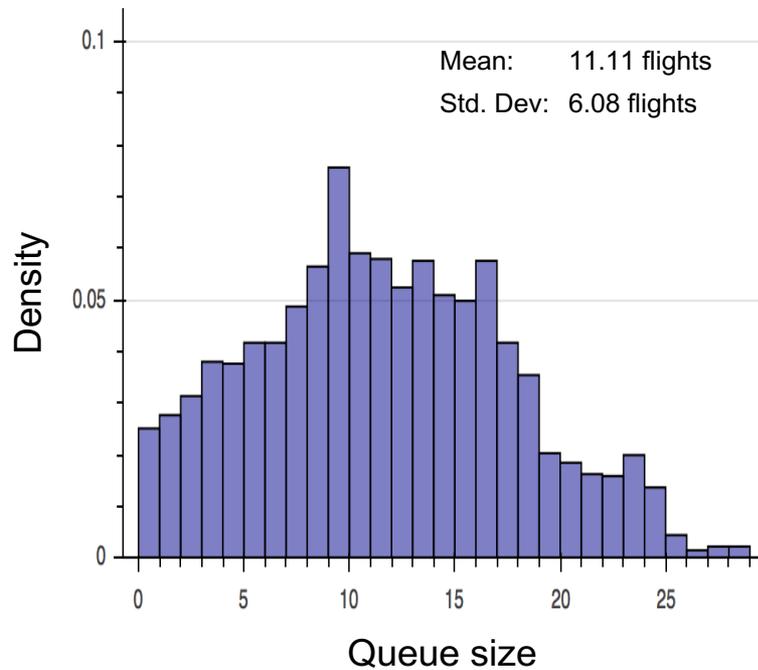
Aggregate other emissions, metric tons



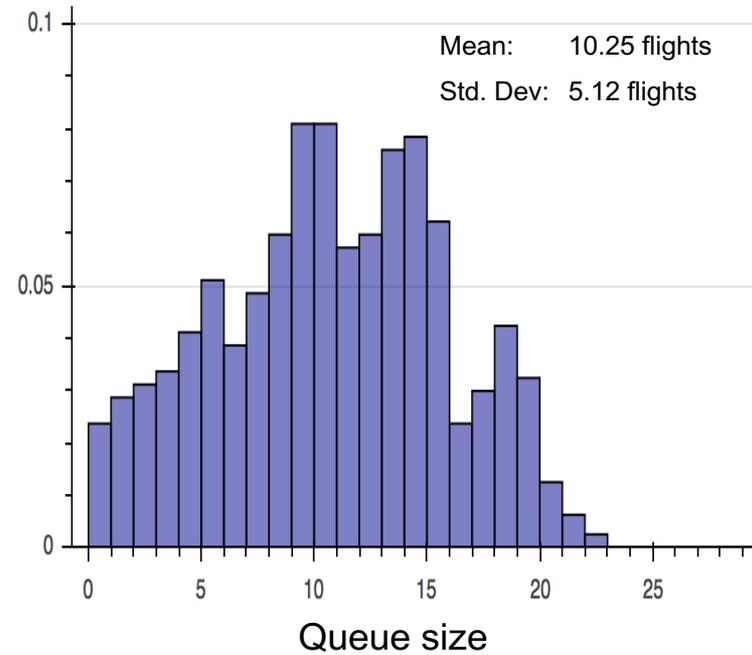


- An initial estimate of fuel and emissions savings can be derived from metering holds at the gate
 - Assumes that realized taxi-out time is reduced by the amount of gate holding due to metering
 - Assumes an all-engine taxi at 7% throttle under standard atmospheric conditions
 - Uses ICAO Databank to obtain fuel flow rates for specific aircraft types
- Applying method to Week 1 of Phase 1C:
 - 961.6 minutes of cumulative metering hold, results in:
 - **4,417 kg fuel savings**
 - **13,575 kg CO₂ reduction**

Departure queue size = number of flights ahead destined for same runway

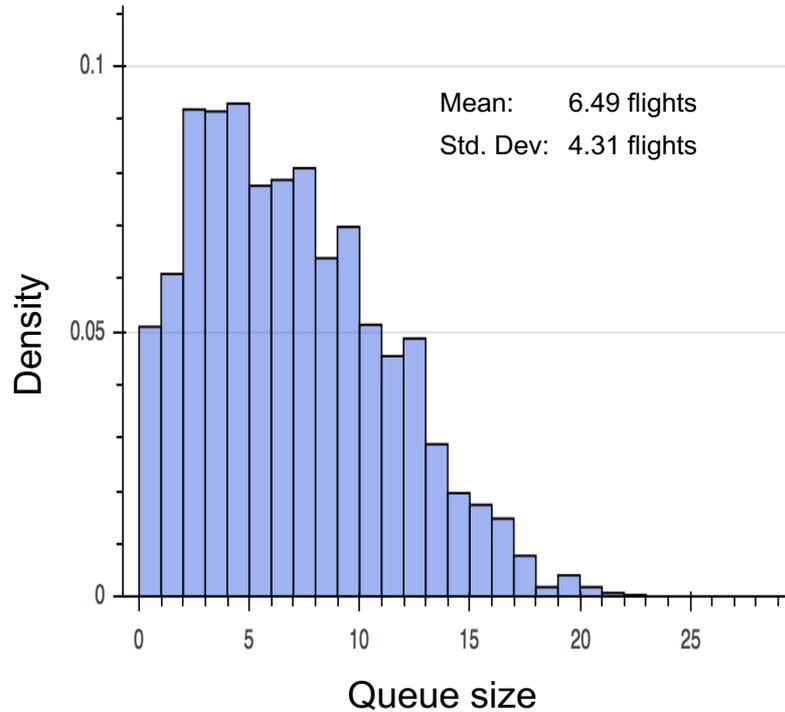


Phase 1B

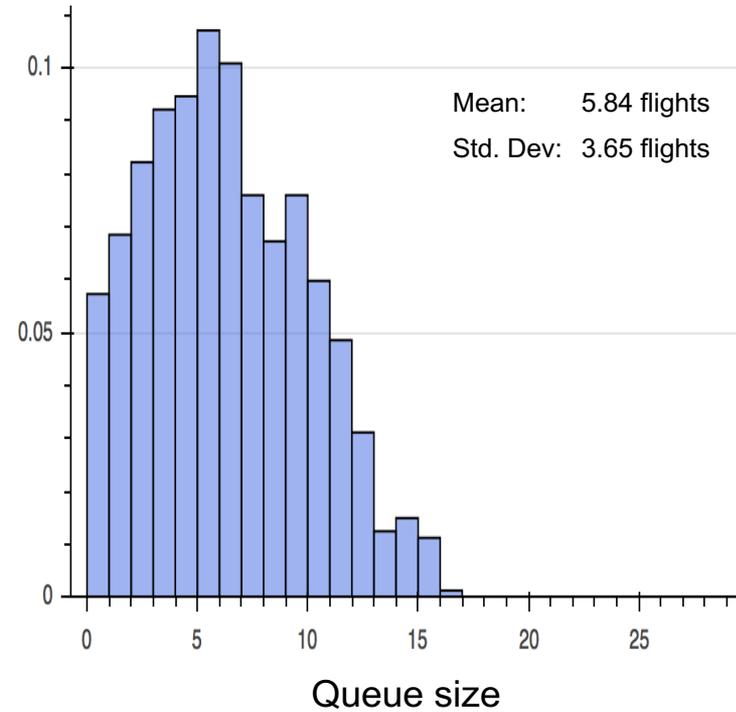


Phase 1C (thru Dec 7)

Departure queue size = number of flights ahead destined for same runway



Phase 1B



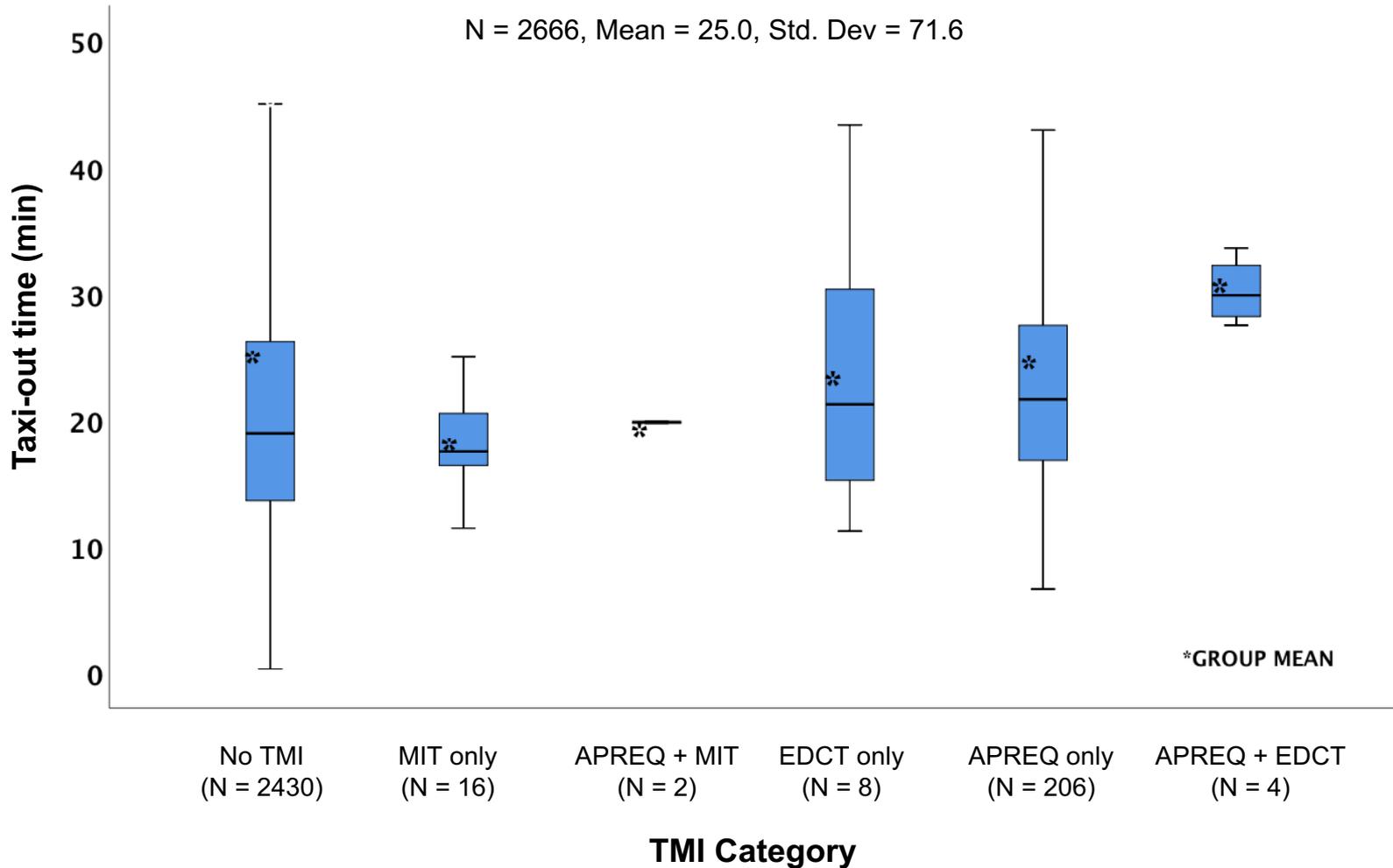
Phase 1C (thru Dec 7)



- Analysis based on Phase 1 field data
 - Phase 1A: Data exchange and integration (Sep 29 – Oct 31)
 - Phase 1B: IDAC style APREQ negotiation with ZDC + Phase 1A (Nov 1 – 29)
 - Phase 1C: Surface metering + Phase 1A & 1B (Nov 29 – present)
- Initial analysis has focused on efficiency metrics:
 - Taxi times for departures and arrivals
 - Excess taxi times relative to unimpeded estimates
 - Fuel and emissions
 - Departure queue size
 - **Taxi times and compliance for flights subject to TMI**
- Rigorous comparisons with baseline (pre ATD-2) operations are forthcoming

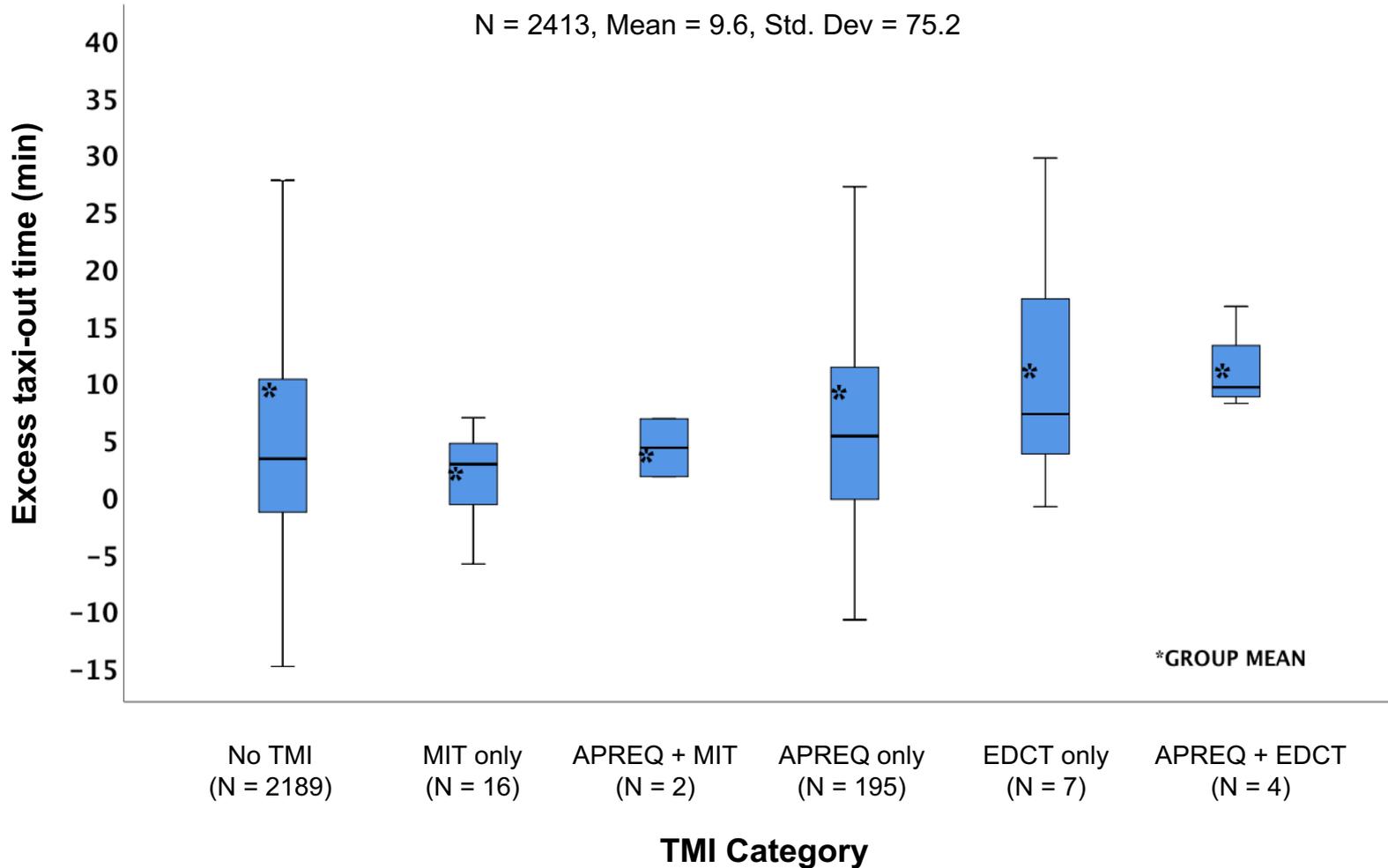
Taxi-out time vs TMI type

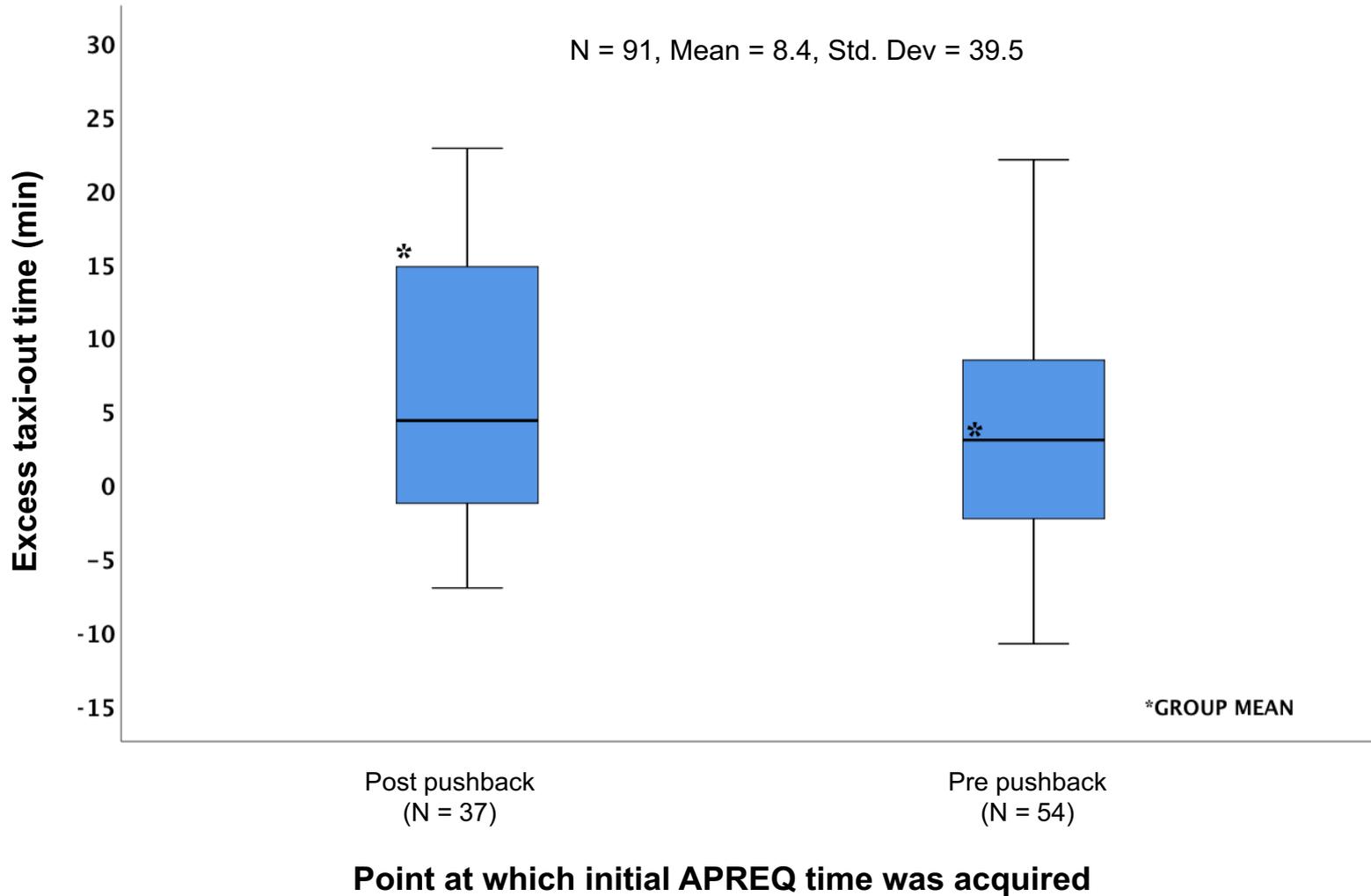
Period = Phase 1B; Bank = 2; Aircraft = All

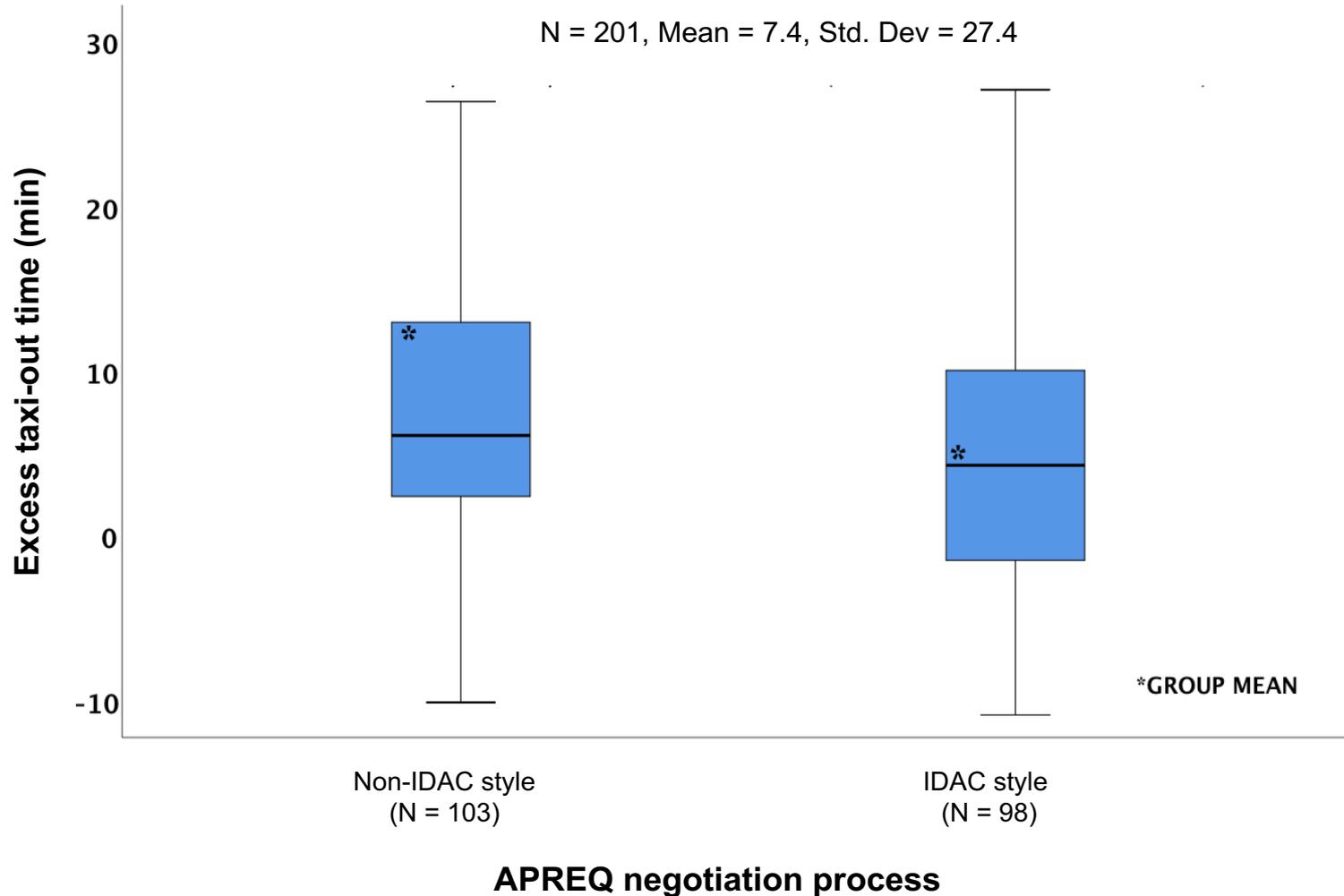


Excess taxi-out time vs TMI type

Period = Phase 1B; Bank = 2; Aircraft = All









- Analysis of compliance with EDCT and APREQ times in progress
 - APREQ wheels-off time window: -2/+1 min
 - EDCT wheels-off time window: -5/+5 min
- Preliminary results suggest improved APREQ compliance with IADS automation
 - Improvement with IDAC style negotiation of times, supported by trajectory-based off-time predictions
 - Improvement with APREQ time acquisition prior to pushback
 - Coupling of the these effects needs further study, supported by additional data

- Continue to collect and examine data from Phase 1C operations
- Examine effect of metering holds on taxi times and on-time performance
- Expand and refine APREQ and EDCT compliance analysis
- Validate preservation of departure and arrival throughput
- Augment results with human-factors data and analysis
- Quantify actual benefits by comparing against baseline (pre IADS) operations



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- Questions?



Thank you!