

# Latest Strategic Surface Metering System and Progress Status in CLT

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

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- Overview of Surface Metering
- Tactical Surface Metering
- Strategic Surface Metering
- Flight Prioritization
- Leveraging Surface Metering
- Lessons Learned and Future Plans

# Overview of Surface Metering

- Departure surface metering reduces fuel burn and surface congestion by holding flights at the gate instead of in the AMA in departure queues
- ATD-2 assigns Target Off Block Times (TOBTs) and Target Movement Area entry Times (TMATs) to flights during Surface Metering Programs (SMPs)
  - TOBT is the time the flight should pushback from the gate
  - TMAT is the time the flight should enter the movement area
- TOBTs and TMATs are assigned to reduce excess taxi time to a target value
  - Excess taxi time is the amount of time beyond unimpeded taxi time that the flight is predicted to spend taxiing on the airport surface

Crawl → Walk → Run

## Scheduling

- Predict TTOTs
- Schedule flights into overhead stream

## Tactical Metering

- Assign TOBTs and TMAATs when metering is needed

## Strategic Metering

- Predict SMPs
- Freeze TOBTs and TMAATs
- Freeze metering start time

# Tactical Surface Metering (Phase 1)

- Metering triggered based on departures currently off the gate and flights pushing back within the next 10 minutes
  - A flight off the gate must be predicted to have an excess taxi time greater than a set target excess taxi time
  - A flight at the gate must be predicted to have an excess taxi time greater than a set upper threshold
- TOBTs and TMA Ts assigned to flights still at the gate and updated as needed
  - A flight's TOBT and TMA T are frozen when the pilot calls ready for pushback and the ramp controller puts the flight on hold
- Metering turns off based on departures currently off the gate and flights pushing back within the next 10 minutes
  - All flights must be predicted to have an excess taxi time of less than a set lower threshold



- Metering start
  - Initially, ATD-2 was tactically triggering metering based only on flights predicted to pushback in the next
    - Found that metering was triggering too early and there was a slow start to metering
  - ATD-2 updated tactical trigger for metering to include departures off the gate
- Targets and thresholds different per runway
  - Initially, ATD-2 had a single target and set of thresholds for all runways
    - Found that different targets were needed for the east and west runways
  - ATD-2 was updated to support metering parameters per runway

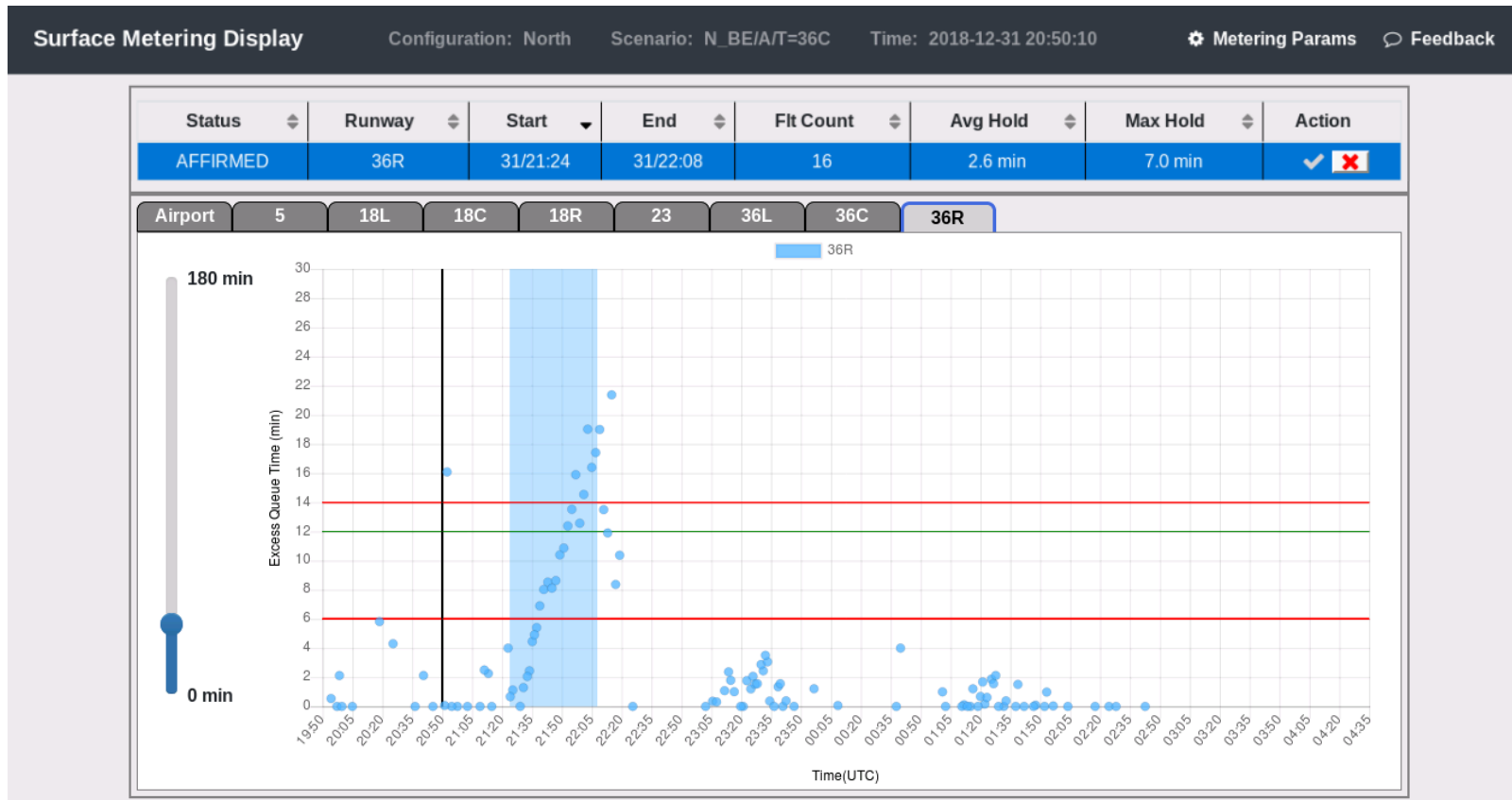


# Strategic Surface Metering (Phase 2)



- Goals
  - Incorporate lessons learned from tactical scheduler during Phase 1
  - Incorporate additional concepts from TFDM and prepare for transition to TFDM
  - Provide planning tools on the strategic timeframe
    - Provide predictions at longer look-ahead times
    - Provide advanced notice of metering
    - Provide TOBTs and TMATs with more lead time
  - Continue to make use of tactical data, such as readiness information
- The strategic planning tools were added to the existing tactical scheduler
  - Surface Metering Programs (SMPs) were added similar to TFDM

- Predict when metering will be needed in advance
- Allows users to collaborate on recommended metering program
  - Affirm or reject the recommended SMP
- ATD-2 SMPs are automatically adjusted at regular intervals based the latest data



- At the beginning of the day, surface metering capability is off



- Prior to bank 2, TMC turns on “Time-Based Metering” capability in the Surface Metering Display (SMD)



- TMC and ramp manager collaborate to set desired metering parameters
  - Targets and Thresholds are set to the same values as they were in with the Phase 1 tactical surface metering capability
  - New strategic parameters
    - Lead Time – What is the farthest in advance that an SMP should be recommended?
      - Currently set to 60 minutes
    - Static Time Horizon – Freezes TOBT and TMAT a set number of minutes in advance

- Set desired metering parameters (continued)

Resource	5	36R	36C	36L
Upper Threshold	0	14	12	0
Target Threshold	0	12	10	0
Lower Threshold	0	6	5	0
Last Update Time	04/08:00	04/08:00	04/08:00	04/08:00

Airport

5/23

18L/36R

18C/36C

18R/36L

Parameter	Current Value	New Value
Enable Metering:	TIME_BASED_METERING	<input checked="" type="radio"/> Time-Based Metering <input type="radio"/> Departure Sequence Metering <input type="radio"/> No Metering
Lead Time:	60 min	<input style="width: 100%;" type="text"/> min
Static Time Horizon:	0 min	<input style="width: 100%;" type="text"/> min

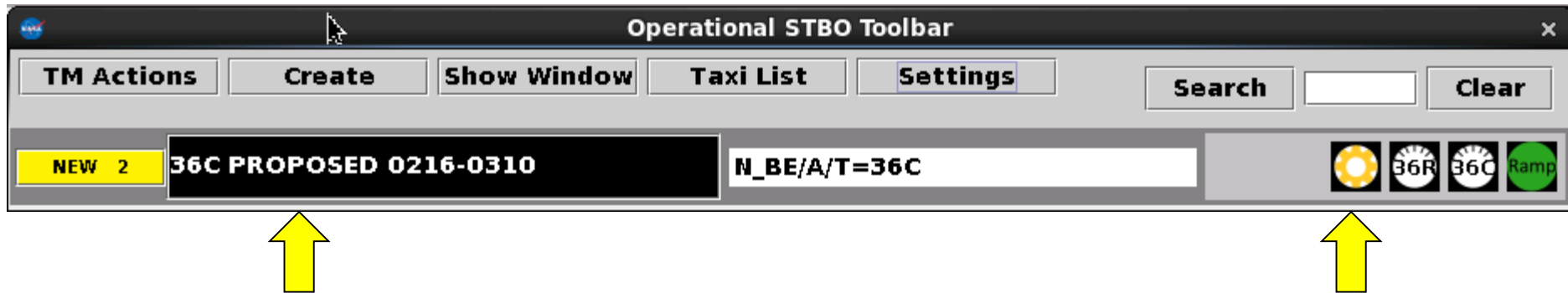
Set Airport Parameters

Clear Airport Parameters

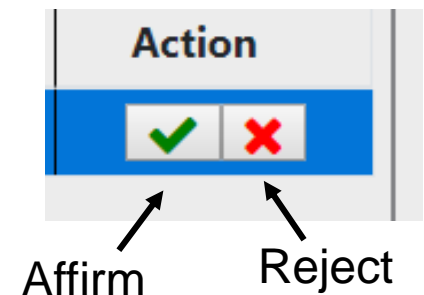
Set All Parameters

Clear All Parameters

- An SMP is recommended once the need for metering is detected within the Lead Time
  - Users are notified of the proposed SMP in the toolbar



- If auto-affirm is enabled, the SMP will be immediately affirmed
- If auto-affirm is not enabled, TMC and ramp manager make decision to affirm or reject SMP
  - If SMP is affirmed, the metering will turn on at appropriate time
  - If SMP is rejected, then metering will not turn on
  - If no action is ever taken, then metering will not turn on



Status	Runway	Start	End	Flt Count	Avg Hold	Max Hold	Action
AFFIRMED	36R	31/21:29	31/22:10	13	2.7 min	6.5 min	<input checked="" type="checkbox"/> <input type="checkbox"/>

- Status – Current status of the SMP
- Runway – the runway that metering will be needed on
- Start – the predicted start time of metering
- End – the predicted end time of metering
- Flt Count – the predicted number of flights that will be assigned a gate hold
- Avg Hold – the predicted average gate hold assigned to each flight
- Max Hold – the predicted maximum gate hold assigned to during metering

- **PROPOSED**
  - The ATD-2 system is recommending metering and no user action has been taken
- **AFFIRMED**
  - A user has affirmed the SMP or auto-affirm is enabled
  - And the ATD-2 system is still predicting that metering will be needed
- **REJECTED**
  - A user has rejected the SMP but the ATD-2 system is still recommending metering
- **ACTIVE**
  - An affirmed SMP has started. Metering is now active for the runway
- **COMPLETED**
  - An active SMP has ended or been terminated early by a user
- **OBSOLETE**
  - The ATD-2 system is no longer recommending metering for this runway
  - Affirmed and rejected SMPs can become obsolete



User Inputs

User Actions

User Priorities

1<sup>st</sup> Pass:  
Metering  
  
First-Scheduled  
First-Served  
(FSFS)  
  
or  
  
First-Come  
First-Served  
(FCFS)

SMP Detection  
  
Strategic  
or  
Tactical

If metering,  
  
• Assign TOBTs  
and TMATs  
  
• Prioritize flights

2<sup>nd</sup> Pass:  
Prediction  
  
First-Come  
First-Served  
(FCFS)  
based on  
assigned TOBTs

Outputs

SMPs

TOBTs and  
TMATs

TTOTs for  
Timeline

# Flight Prioritization

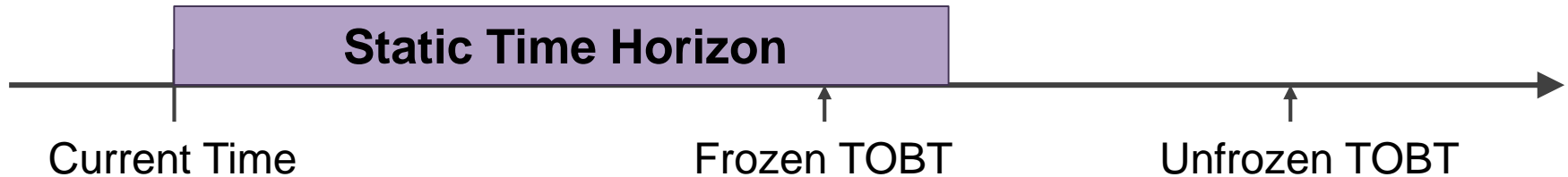
- The ramp manager can mark a flight as priority through the Ramp Manager Traffic Console (RMTC) tool
- During metering, the scheduler will perform substitutions among flights with the same major carrier that are part of the same SMP to reduce gate hold on the priority flights
  - RTC shows updated gate hold advisories to ramp controllers
  - ATD-2 publishes the new TOBTs and TMA Ts out TTP SWIM
- With TFDM, airlines will need to translate priorities into a set of substitutions



# Leveraging Surface Metering

- Goal is to provide additional benefits of gate hold to passengers and airlines
  - Airlines need to know with confidence how much gate hold will be assigned to each flight in advance of the flight calling ready for pushback
- Tactical Freeze
  - The TOBT and TMAAT are frozen when the pilot calls ready
  - Readiness indicated either by ramp controller putting the flight on hold or pushing back the flight in RTC
- Strategic Freeze
  - Keeps current tactical freeze
  - New strategic logic allows freeze of TOBT and TMAAT prior to call ready
    - The Static Time Horizon (STH) defines how far in advance the TOBT and TMAAT are frozen

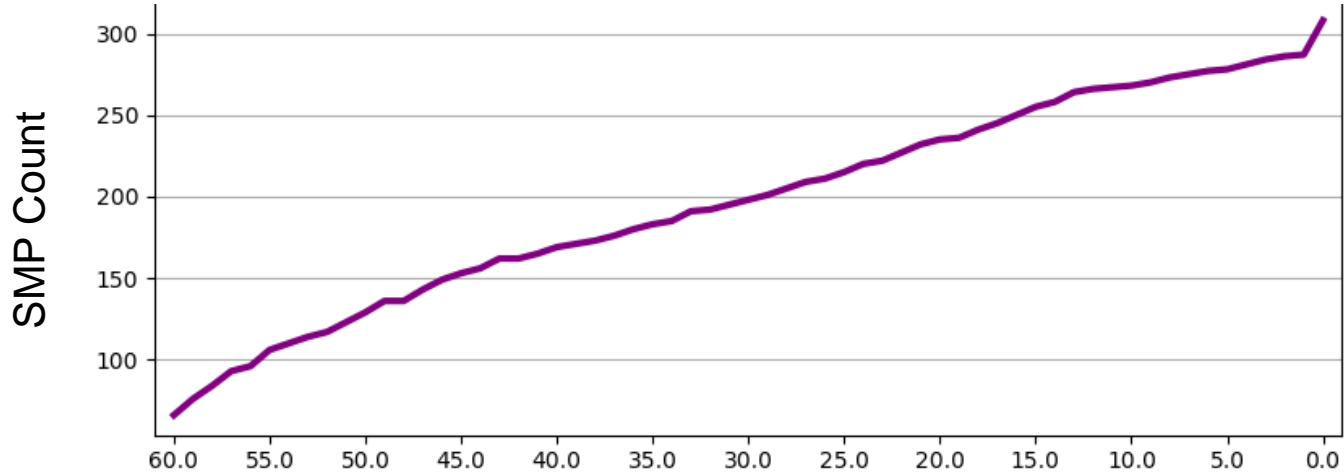
- Flight's with a TOBT inside the STH are frozen



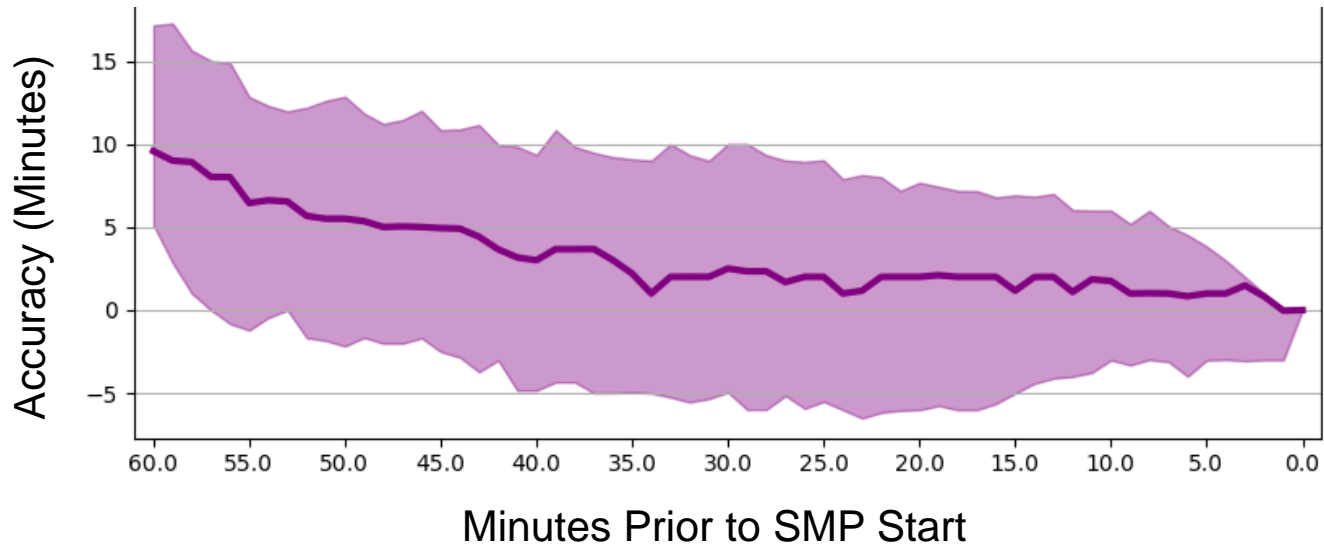
- The size of the Static Time Horizon is a tradeoff between precisely managing the queue and providing stability to flight operations
- Exceptions to strategic freeze
  - Flight gets a new release time or EDCT
  - Airline updates EOBT to a time later than TOBT
    - If new EOBT is within the STH, flight gets new frozen TOBT = EOBT
    - If new EOBT is outside STH, flight gets new unfrozen TOBT  $\geq$  EOBT based on FSFS
  - Ramp manager enters priority through RTC that causes substitutions inside of the STH

- Currently, ATD-2 SMPs predicts when metering will be tactically triggered, but metering does not start until tactical triggers are met
- To be able to leverage surface metering, airlines need to know when metering will start in advance
  - Allows for advance planning
  - Trade-off is that there is a risk of metering starting too early, resulting in a slow start to metering
- Recently added capability to freeze SMP start time when start time is within the Static Time Horizon

## SMP Detection Count

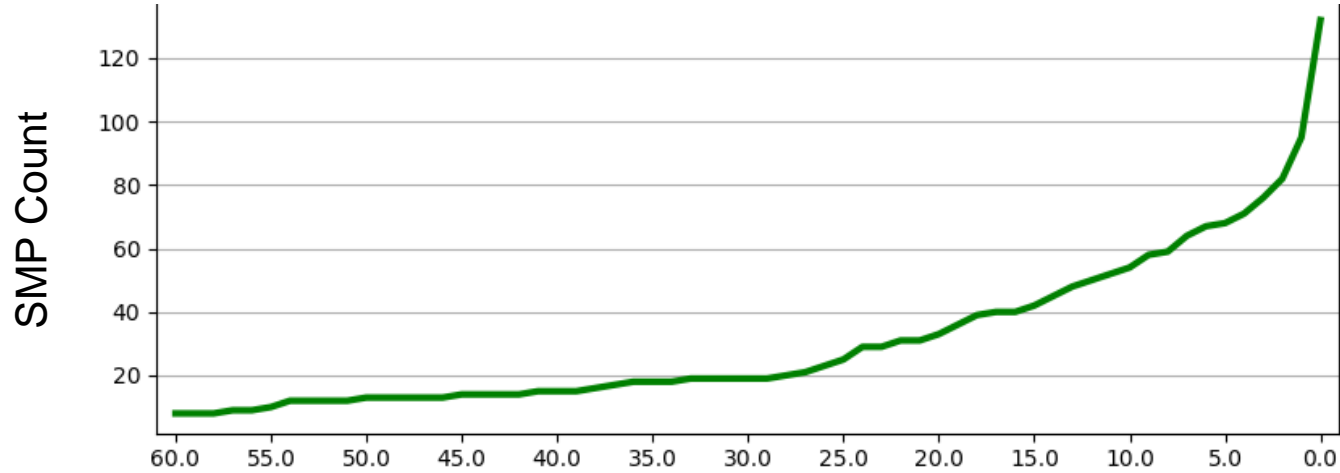


## SMP Start Time Accuracy (Actual - Predicted)

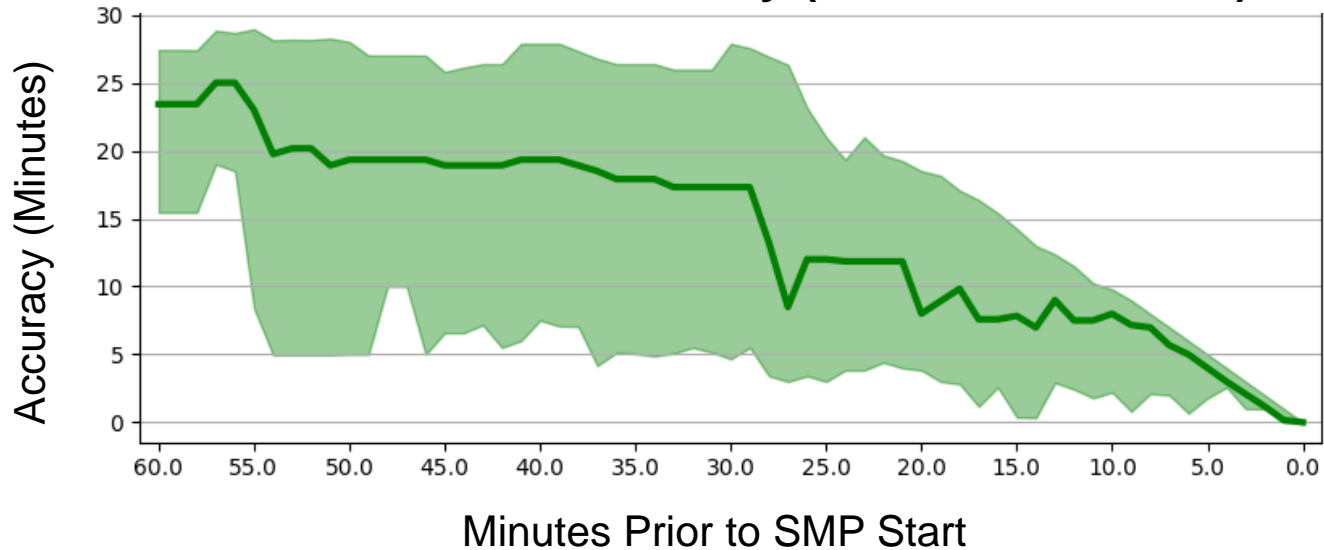




## SMP Detection Count



## SMP Start Time Accuracy (Actual – Predicted)



# Lessons Learned and Future Work



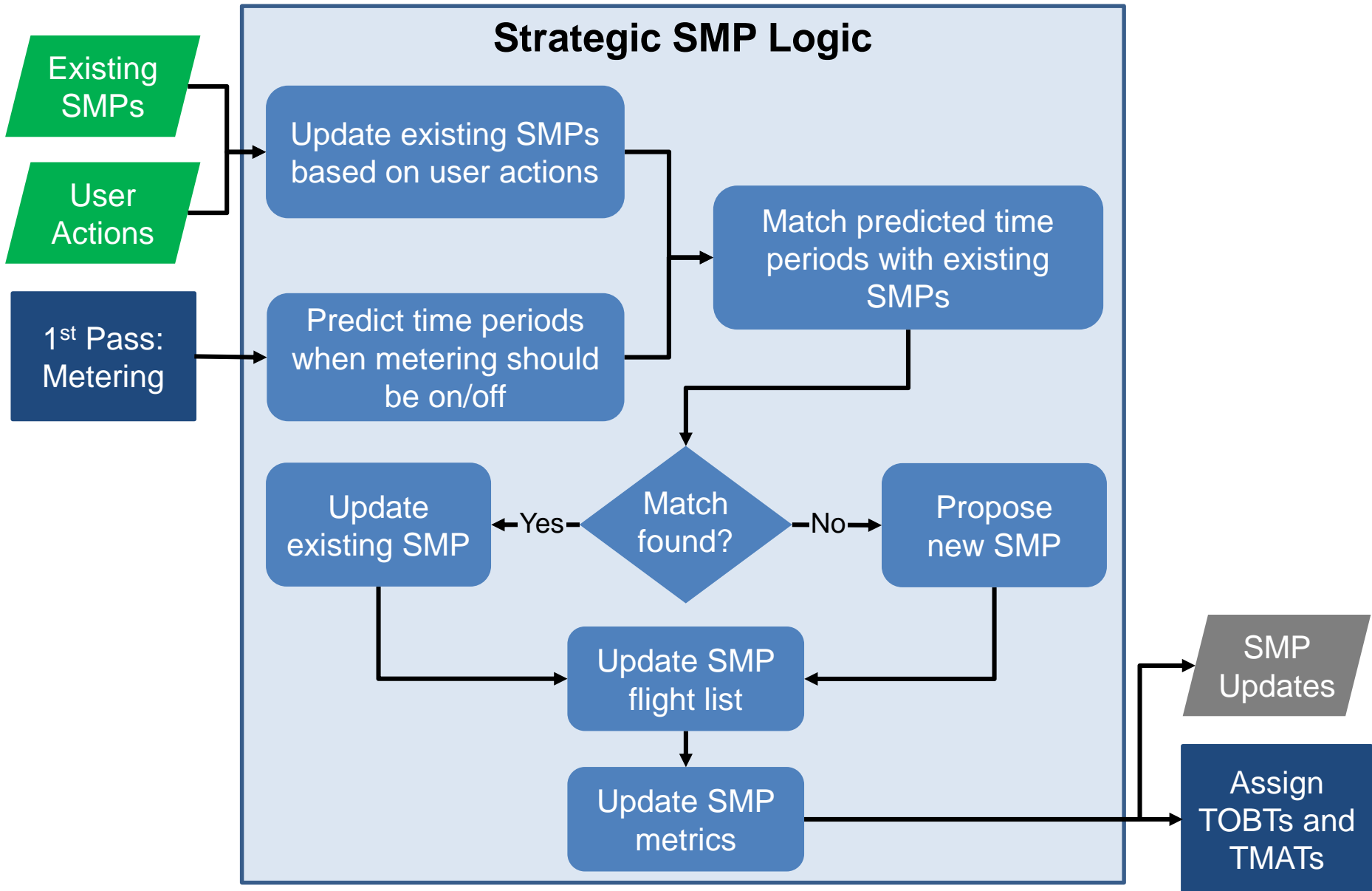
- Accurate predictions of future gate holds are needed to accurately predict when metering should start and stop
- Auto-Affirm SMPs
  - New capability added due to reduce TMU and ramp manager workloads
  - When not auto-affirming SMPs, the notification for a recommended SMP needs to be obvious as users are not always looking at display

The following future work is planned for the final year of ATD-2 to help CLT transition from ATD-2 to TFDM

- Continue testing the use of Static Time Horizon to freeze TMATs
- Add SMP compressions within the Static Time Horizon to reduce risk of the runway drying up during metering
- Test freezing the SMP start time
  - Test this capability on specific days in coordination with ramp control and ATC

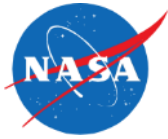
Questions?

# Backup



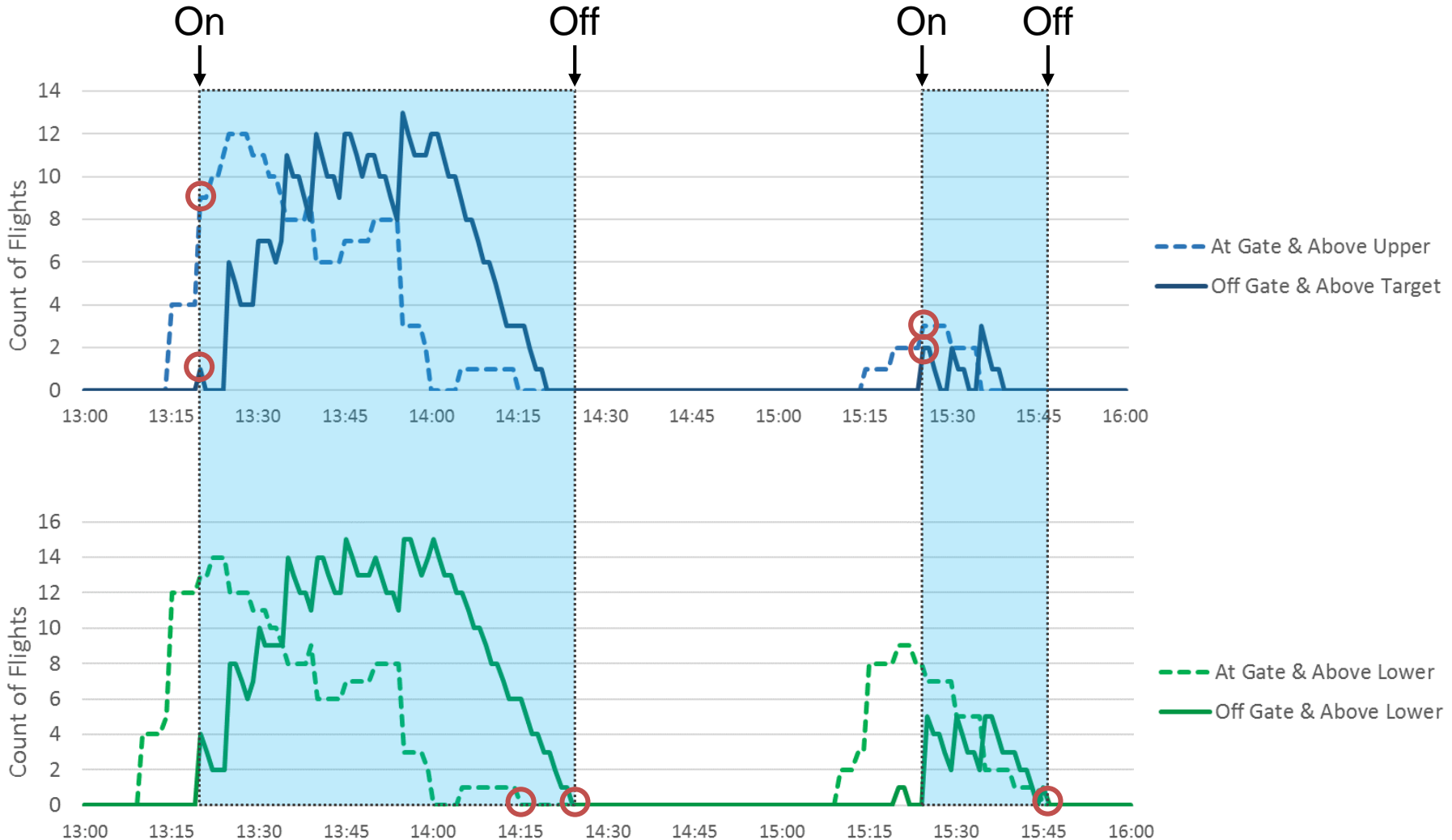
- The strategic SMP algorithms logic first processes user actions received since that last scheduler cycle
- SMPs are initially in a PROPOSED status
  - Unless auto-affirm is turned on, in which case they start out in the AFFIRMED status
- If a user has affirmed a PROPOSED or REJECTED SMP,
  - The SMP status is set to AFFIRMED
- If a user has rejected a PROPOSED or AFFIRMED SMP,
  - The SMP status is set to REJECTED
- If a user has rejected an ACTIVE SMP ending it early,
  - The SMP status is set to COMPLETED as the SMP is now finished
  - The end time of the SMP is set equal to current time





- The strategic SMP algorithms predict when different tactical metering conditions will be met per flight
- Tactical metering triggers
  - Metering On
    - One departure off the gate is predicted to have an excess taxi time greater than Target
    - One departure on the gate predicted to pushback in the next 10 minutes is predicted to have an excess taxi time greater than the Upper Threshold
  - Metering Off
    - No departures taxiing on the airport surface or on the gate within 10 minutes of pushback are predicted to have an excess taxi time greater than Lower Threshold

- The strategic algorithms use the per flight predictions of excess taxi time to predict when metering would be on or off





- The predicted metering on and off time periods are matched to existing SMPs that were created in earlier scheduler cycles
- Matches are made based on overlapping times
- If a match is found,
  - The existing SMPs start and end time are updated
  - If the existing SMP was OBSOLETE, it's state is set to the status prior to OBSOLETE
  - If the existing SMP is AFFIRMED and it's start time is equal to current time, it's start is set equal to ACTIVE
- If no match is found for a predicted metering on time period,
  - A new SMP will be created if the start time is within the Lead Time
    - The status is set to PROPOSED if auto-affirmation is disabled
    - The status is set to AFFIRMED if auto-affirmed is enabled
- If no match is found for an existing SMP,
  - The existing SMP is made OBSOLETE if it is not already active
  - The existing SMP is made COMPLETED if it is active



- For all SMPs that are not COMPLETED or OBSOLETE, the scheduler
  - Identifies flights that are predicted to pushback during the SMP
  - Computes the average and max gate holds for these flights
- These metrics are displayed to the users to help with decision making

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User Actions

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First-Served  
(FSFS)  
  
or  
  
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SMP Detection  
  
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If Metering,  
  
Assign TOBTs  
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Prioritize flights

2<sup>nd</sup> Pass:  
Prediction  
  
First-Come  
First-Served  
(FCFS)  
based on  
assigned TOBTs

Outputs

SMPs

TOBTs and  
TMATs

TTOTs for  
Timeline



- If a departure is part of an ACTIVE SMP (whether tactical or strategic mode) or an AFFIRMED SMP (strategic mode only),
  - The departure is assigned a TOBT and TMAT
- The TOBT and TMAT are assigned using the most recent delay propagation calculations
  - Unless the TOBT and TMAT are frozen in which case frozen times are used
- The TOBT and TMAT are published over TTP to users
- The gate hold advisories based on TOBT are only displayed to ramp controllers once the SMP becomes ACTIVE