Latest Strategic Surface Metering System and Progress Status in CLT

Airspace Technology Demonstration 2 (ATD-2) Industry Workshop

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Outline

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

Overview of Surface Metering

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

ATD-2 Surface Metering Progression

Crawl → Walk → Run

Scheduling

- Predict TTOTs
- Schedule flights into overhead stream

Tactical Metering

- Assign TOBTs and TMATs when metering is needed

Strategic Metering

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

Tactical Surface Metering (Phase 1)

ATD-2 Tactical Metering

- 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 TMATs assigned to flights still at the gate and updated as needed
  - A flight's TOBT and TMAT 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

ATD-2 Tactical Metering Lessons Learned

- 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)

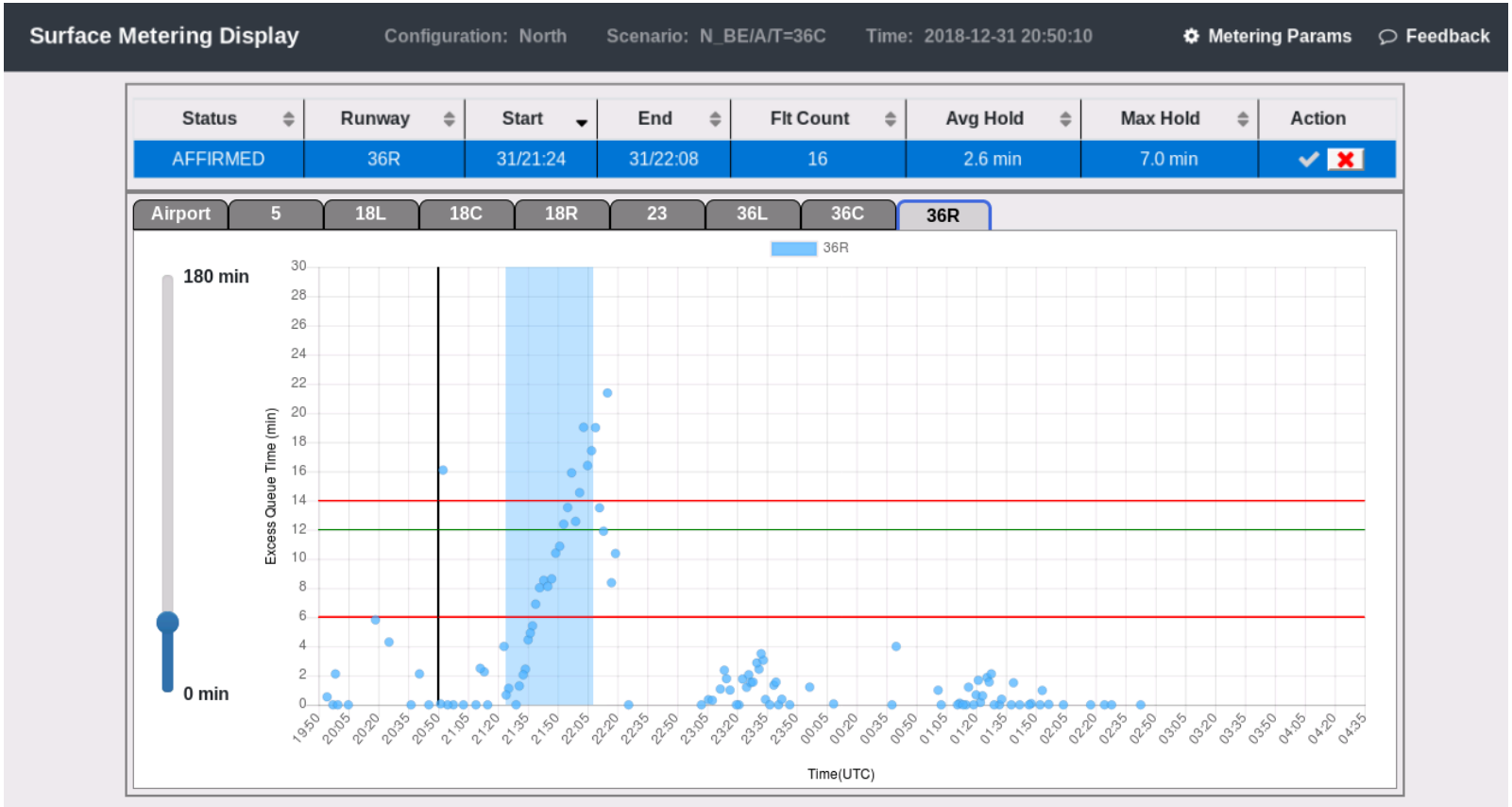
Background on Strategic Surface Metering

- 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

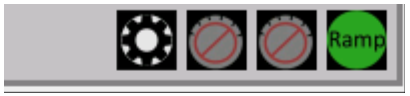
Strategic Surface Metering Programs (SMPs)

- 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

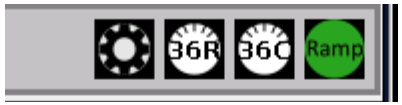


Strategic SMP Work Flow

- 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

Strategic SMP Work Flow

- 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	(•) Time-Based Metering ( ) Departure Sequence Metering ( ) No Metering
Lead Time:	60 min	min
Static Time Horizon:	0 min	min

Set Airport Parameters | Clear Airport Parameters

Set All Parameters | Clear All Parameters

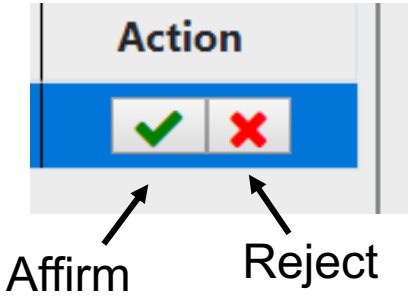
Strategic SMP Work Flow

- 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



SMP Information

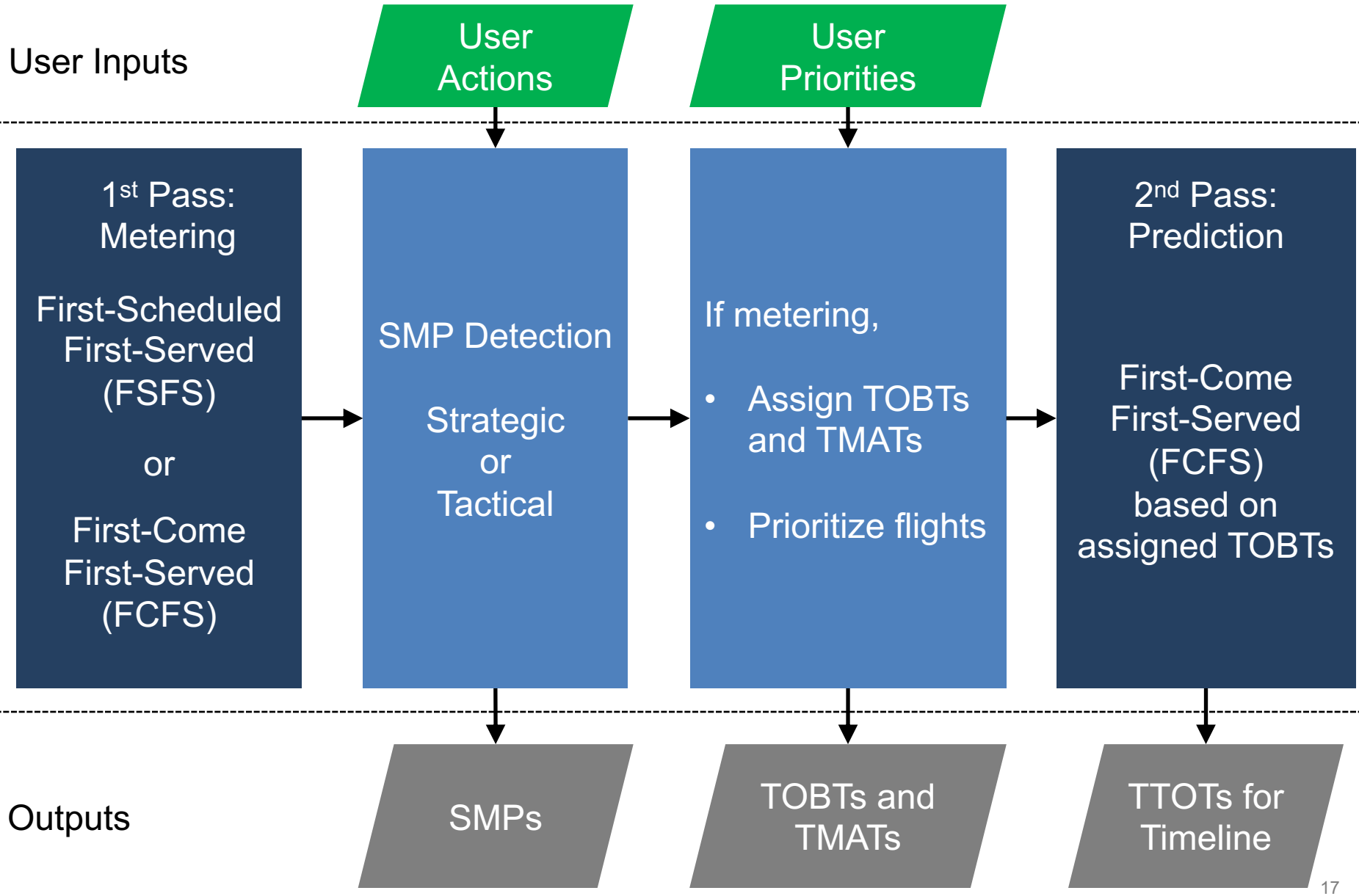
Status	Runway	Start	End	Flt Count	Avg Hold	Max Hold	Action
AFFIRMED	36R	31/21:29	31/22:10	13	2.7 min	6.5 min	✓ ✗

- 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

SMP Status

- 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

Overview of ATD-2 Scheduler Flow



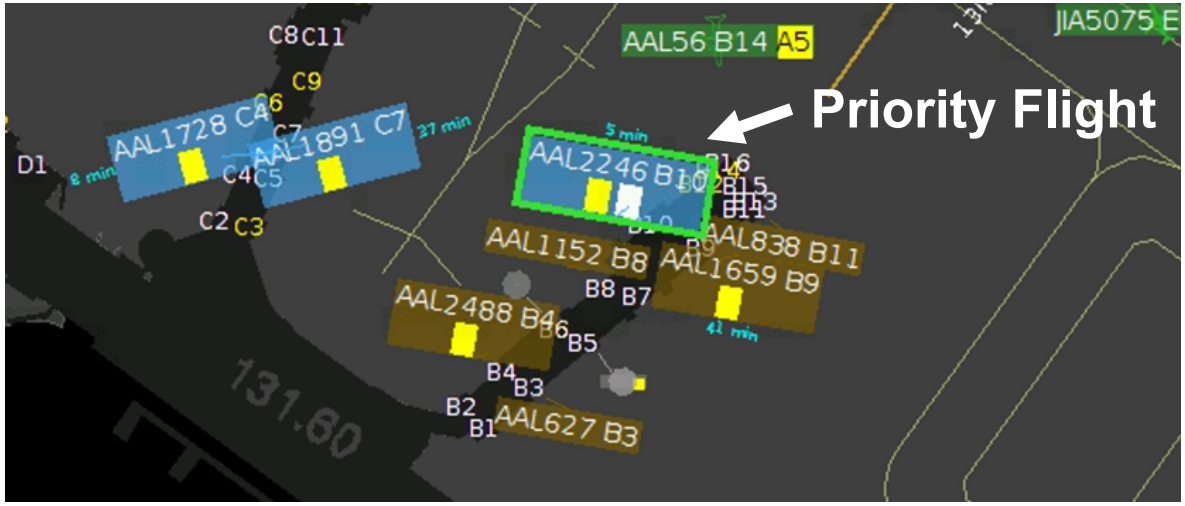
Flight Prioritization

Flight Prioritization

- The ramp manager can mark a flight as priority through the Ramp Manager Traffic Console (RMTC) tool

- During metering, the scheduler will preform 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 TMATs out TTP SWIM

- With TFDM, airlines will need to translate priorities into a set of substitutions



Leveraging Surface Metering

Leveraging Surface Metering

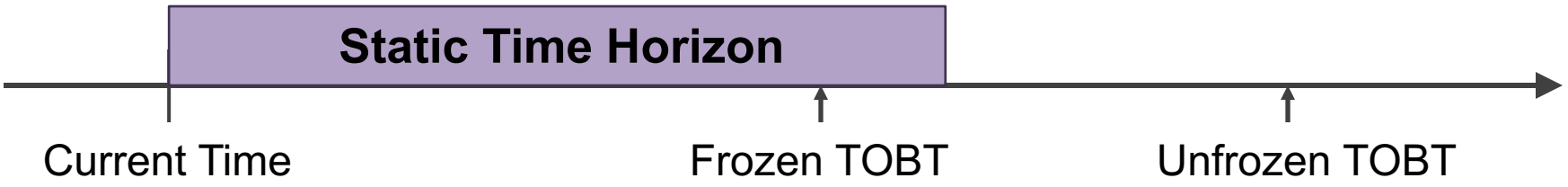
- Goal is to provide additional benefits of gate hold to passengers and airlines
  - Airlines need to know with confidence how much gate hold will be assigned to each flight in advance of the flight calling ready for pushback

- Tactical Freeze
  - The TOBT and TMAT 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 TMAT prior to call ready
    - The Static Time Horizon (STH) defines how far in advance the TOBT and TMAT are frozen

Static Time Horizon

- 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 >= EOBT based on FSFS
  - Ramp manager enters priority through RTC that causes substitutions inside of the STH

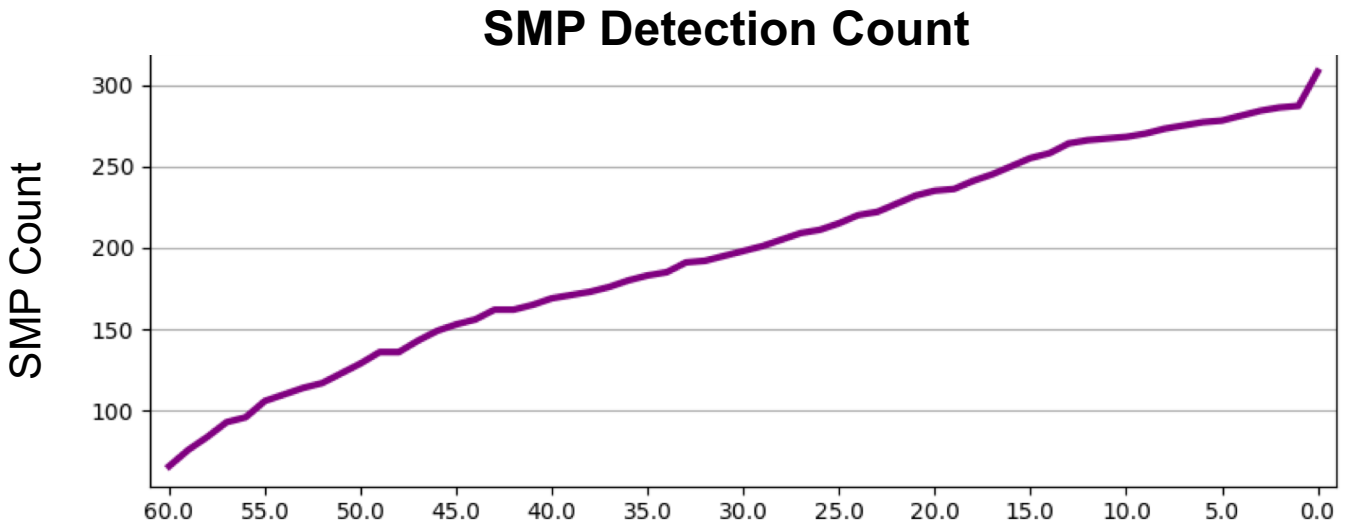
Freezing SMP Start Time

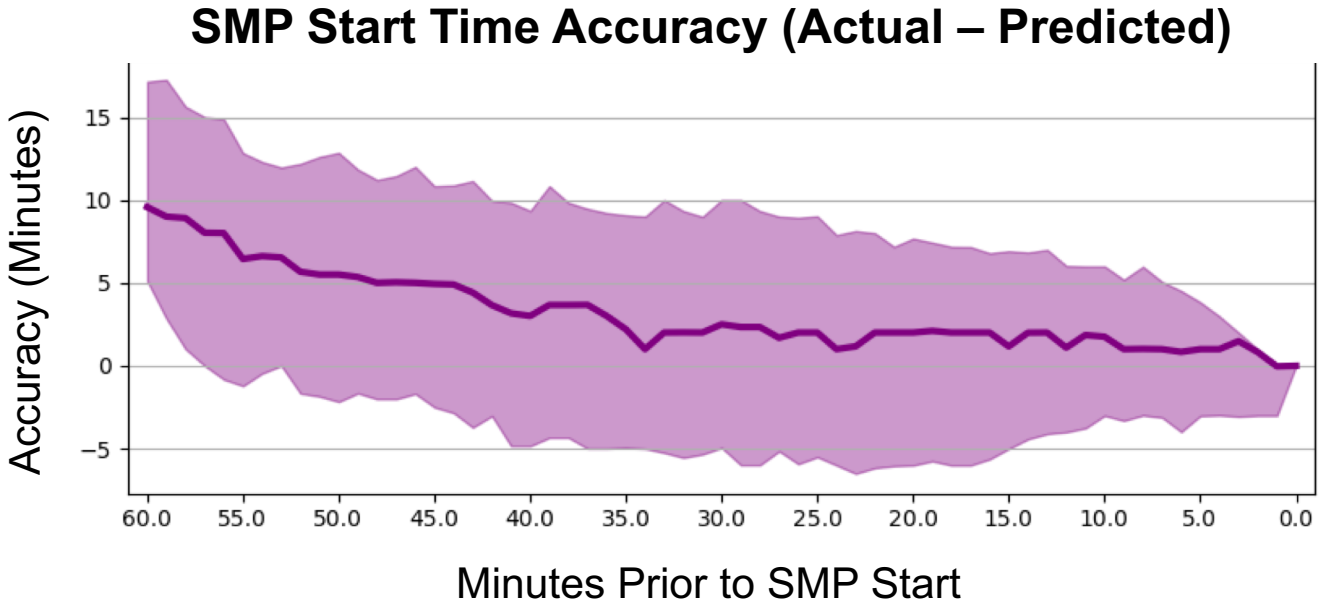
- Currently, ATD-2 SMPs predicts when metering will be tactically triggered, but metering does not start until tactical triggers are met

- 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

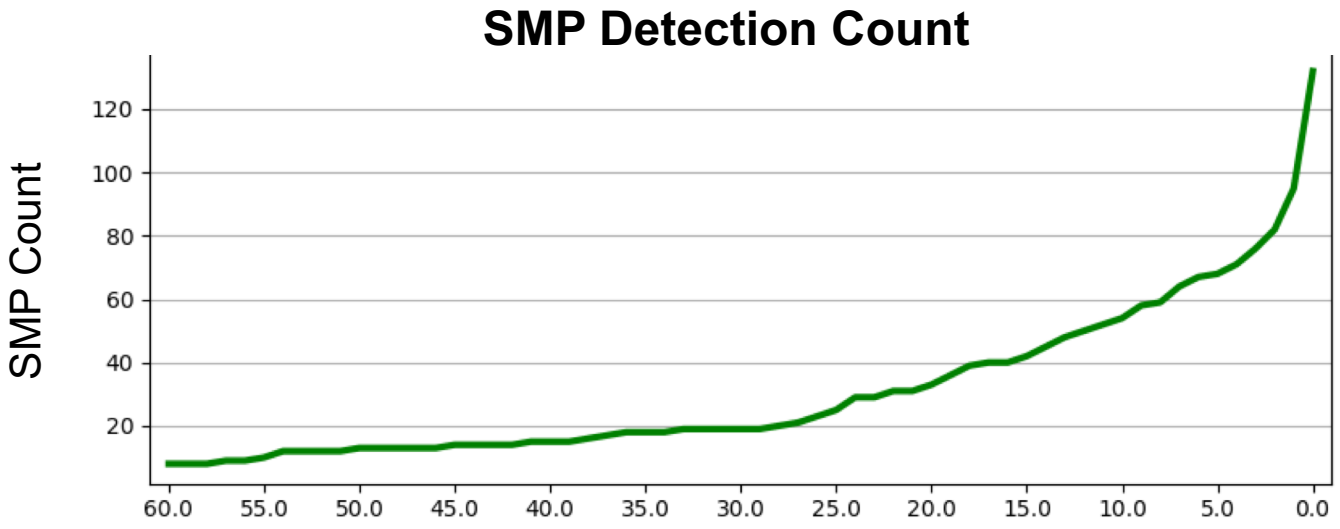
- Recently added capability to freeze SMP start time when start time is within the Static Time Horizon

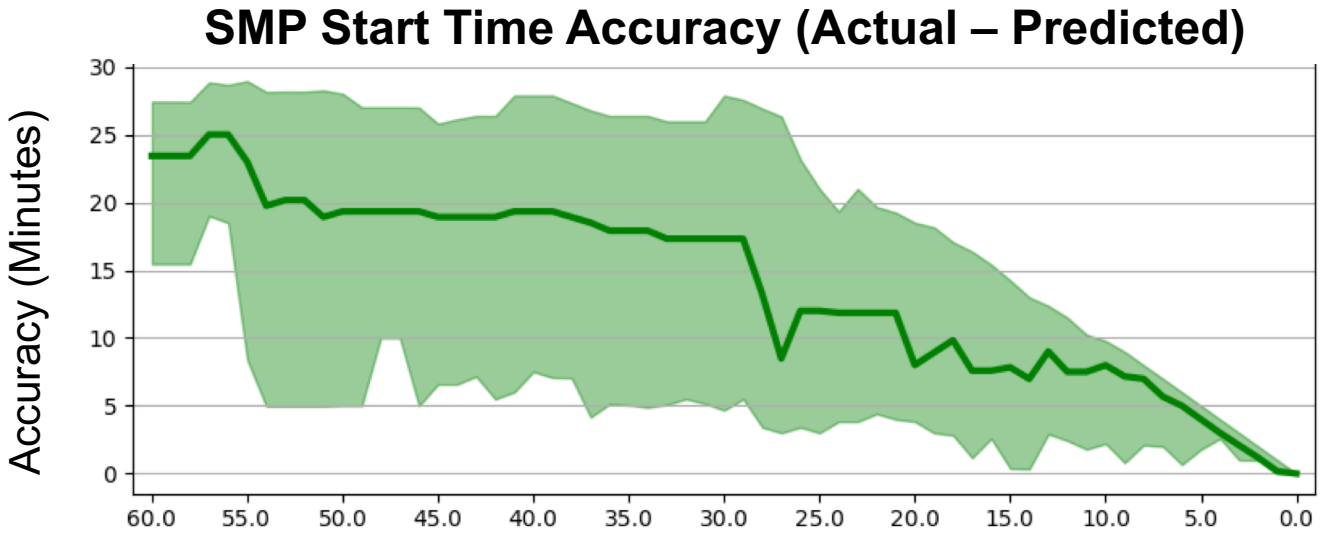
Runway 36R Runway Prediction Accuracy





Runway 36C Runway Prediction Accuracy





Lessons Learned and Future Work

Strategic Metering Lessons Learned

- 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

Future Work

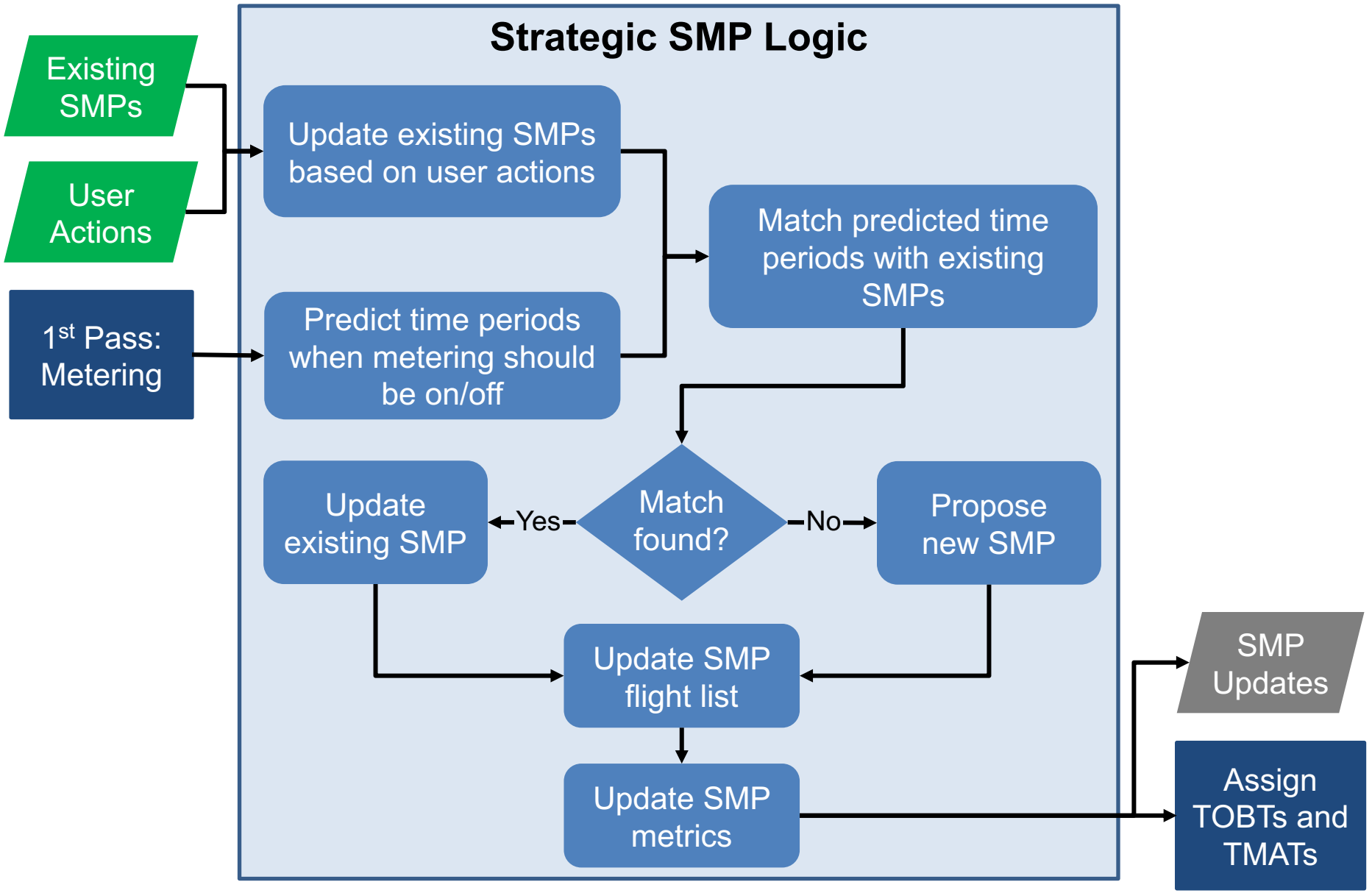
The following future work is planned for the final year of ATD-2 to help CLT transition from ATD-2 to TFDM

- 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

Strategic SMP Logic Overview



Processing of User Actions

- 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

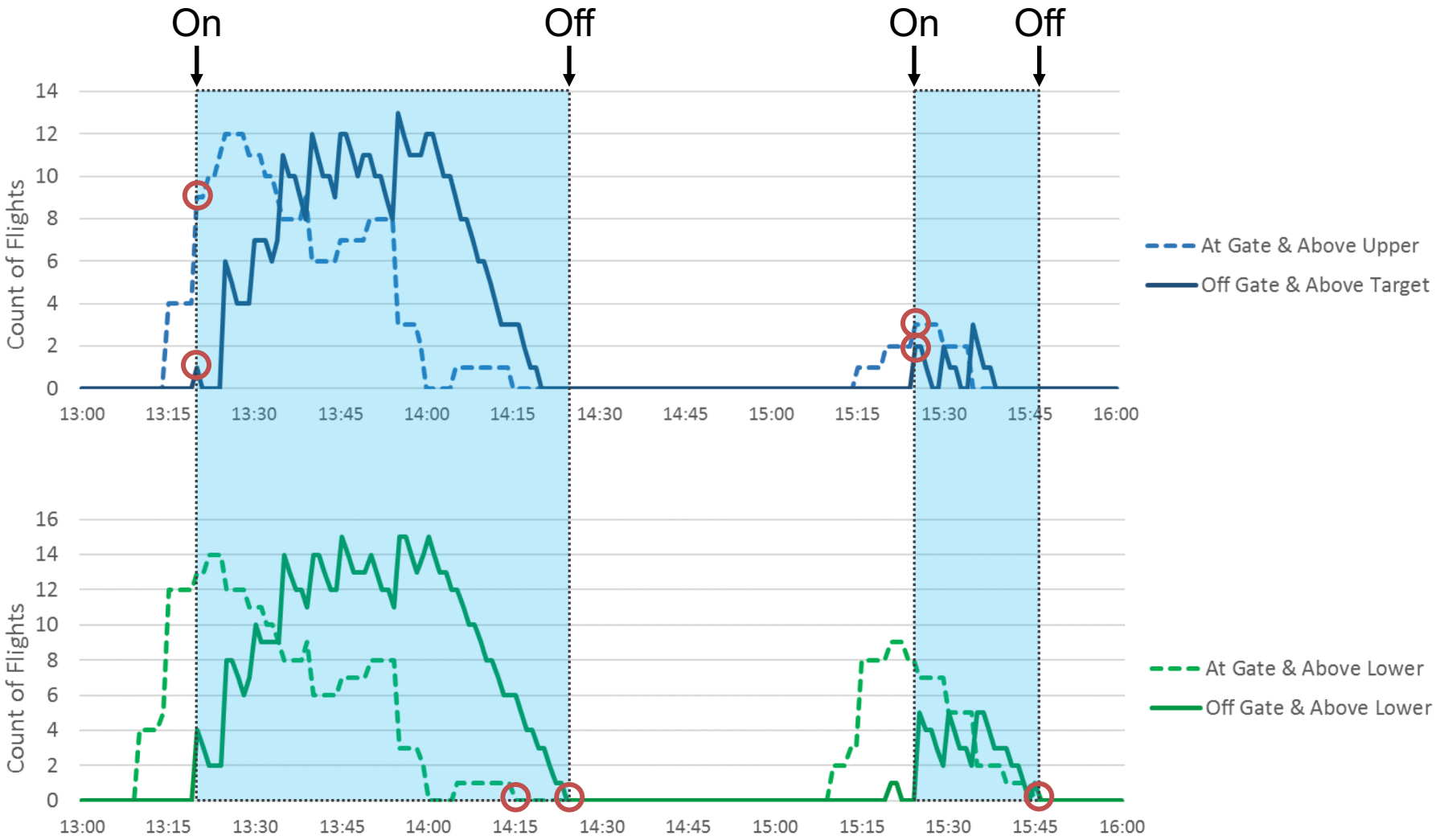
- If a user has rejected an ACTIVE SMP ending it early,
  - The SMP status is set to COMPLETED as the SMP is now finished
  - The end time of the SMP is set equal to current time

Predicting Tactical Triggers Per Flight

- 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

Predicting Tactical Metering Periods

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



Match Predictions with Existing SMPs

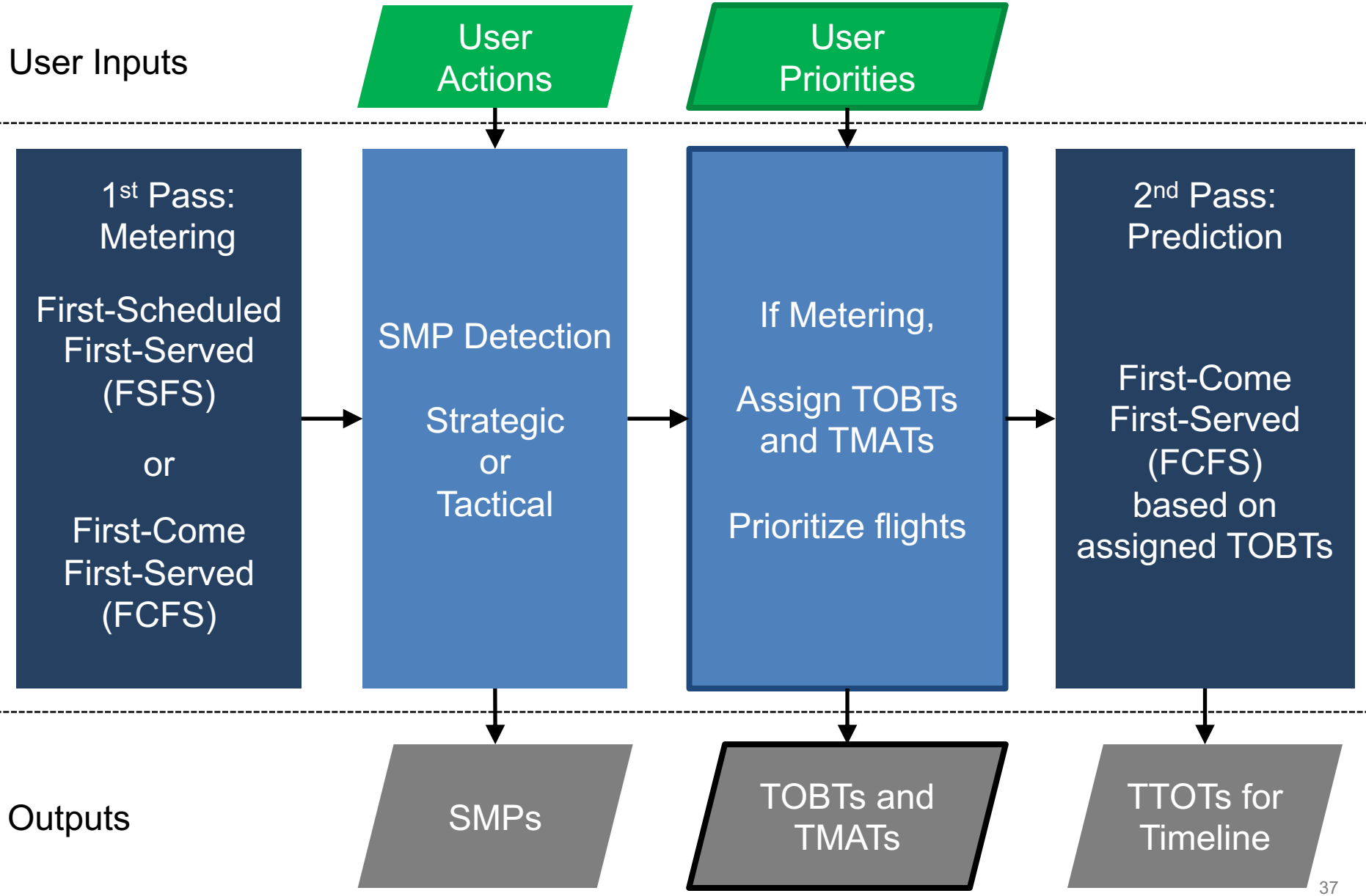
- The predicted metering on and off time periods are matched to existing SMPs that were created in earlier scheduler cycles
- Matches are made based on overlapping times
- If a match is found,
  - The existing SMPs start and end time are updated
  - If the existing SMP was OBSOLETE, it's state is set 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

Updating Flights and Metrics

- 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

Overview of ATD-2 Scheduler Flow



TMAT Assignment

- 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