Surface CDM Implementation

Presented to: Workshop on Airport Collaborative Decision Making

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Collaborative Decision Making

- Collaborative Decision Making (CDM) is a joint government/industry initiative aimed at improving air traffic flow management (ATFM)
- CDM is an operating paradigm where ATFM decisions are based on a shared, common view of the NAS and an awareness of the consequences these decisions may have on the system and its stakeholders

CDM
Collaborative
Decision Making

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CDM History

- Collaborative Decision Making group formed in the mid-1990s
  - Extensive surface delays with a lack of information sharing
  - Industry and FAA joined forces to solve problems and to encourage technological evolution
  - Ration by schedule
  - Flight Intent Data
  - ATC Information
    - Delays
    - Other applicable information
- CDM was formed to address challenges strategically

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CDM and Surface Delay Solutions

CDM Stakeholders Group (CSG) Oversees Tasks

- 2006 - 2010
  - Surface CDM Working Group
    - Identify surface management solutions
    - Identify essential data elements
    - Initial Concept of Operations
- 2011 - 2015
  - Surface Stakeholders Group
    - Concept of Operations Evolution
    - Technical Review HITLs (2012)
    - ConOps Revision to TFDM (2013)
    - Policy and Procedures (2014)

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Terminal Flight Data Manager (TFDM)

- The Surface Management solution for the National Airspace System (NAS)
- TFDM capabilities include
  - Electronic Flight Data
  - Traffic Flow Management
  - Collaborative Decision Making (CDM) for the surface

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Collaborative Site Implementation Team (CSIT)

CSIT performs three basic functions for TFDM

- Liaison to non-FAA stakeholders
- Data collection for program
- Guide local stakeholders in establishing local collaboration

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CSIT Tasks

- Provide flight operators and airports with TFDM orientation and support leading up to implementation
- Site visits to the 27 airports that will deploy surface metering capabilities to
  - provide in-depth TFDM information
  - collect data for the program office to aid implementation
  - provide guidance for local collaboration
- CSIT activities will occur between 2018 to 2024

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CDM and CSITs Today

- Surface CDM Team
  - Subject Matter Expertise
  - Representatives May Participate
- Site Visits
- Current Surface Management Capability
  - NASA ATD-2
  - CLT and DFW

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Concept of Surface Metering

- Efficiency Program
  - Manages number of planes waiting in the departure queue
- Holding your place in line
- Actual departure time is relatively the same
- Fuel Savings

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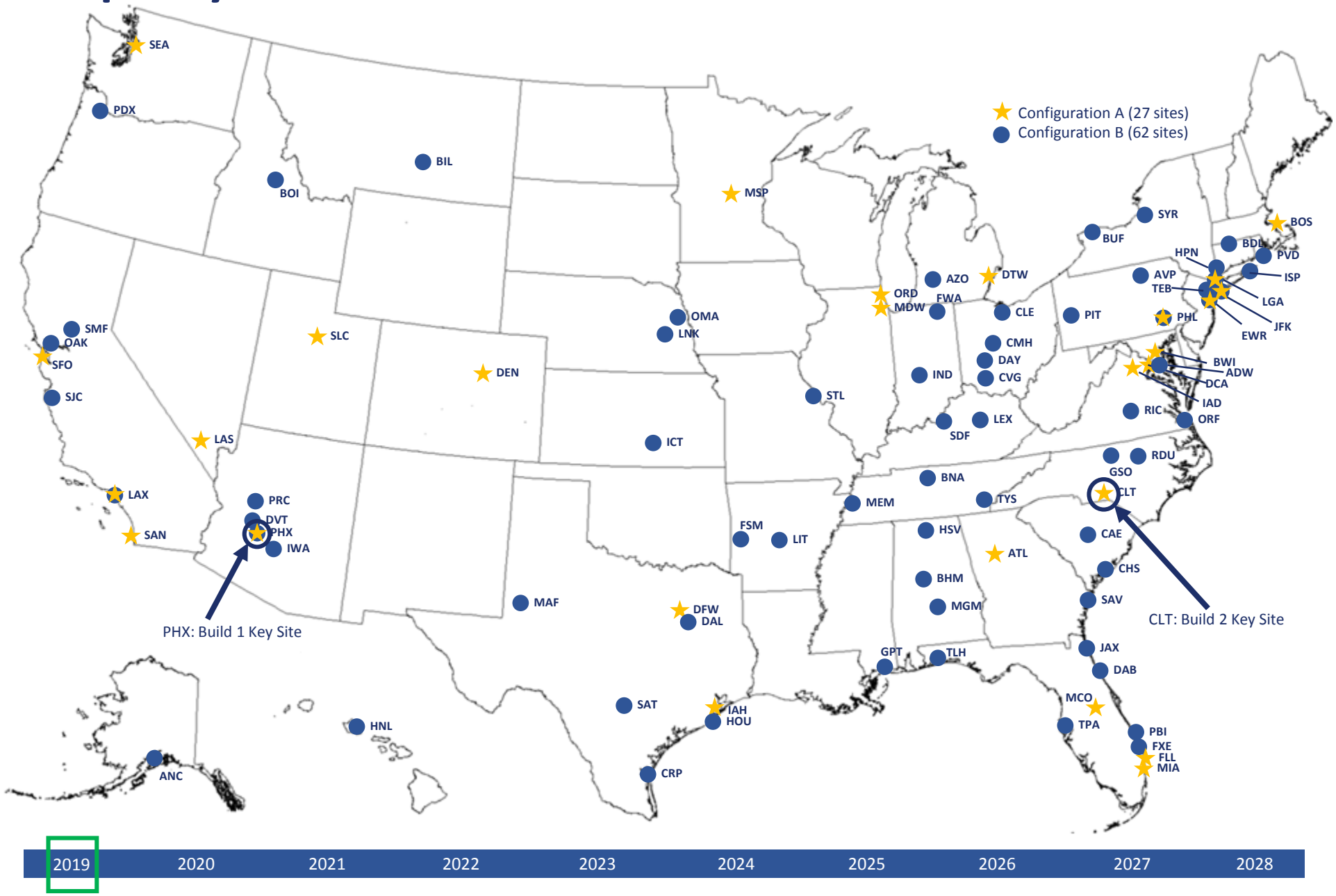
TFDM Deployment Sites



Functions of TFDM

- **Improved Electronic Flight Data Exchange and Electronic Flight Strips:** TFDM will provide improved Electronic Flight Data (EFD) exchange. Electronic Flight Strips (EFS) will replace paper flight strips in the tower and the new functionality will automatically update controller displays with the latest information.

- **Surface Collaborative Decision Making**: TFDM will provide a real-time schedule of all airplanes arriving and departing, which will support surface metering and traffic flow management.

- **Traffic Flow Management** Integrating TFDM data with other FAA systems, such as TBFM (Time Based Flow Management) and TFMS (Traffic Flow Management System), allows airlines, controllers, and airports to more efficiently manage the flow of aircraft

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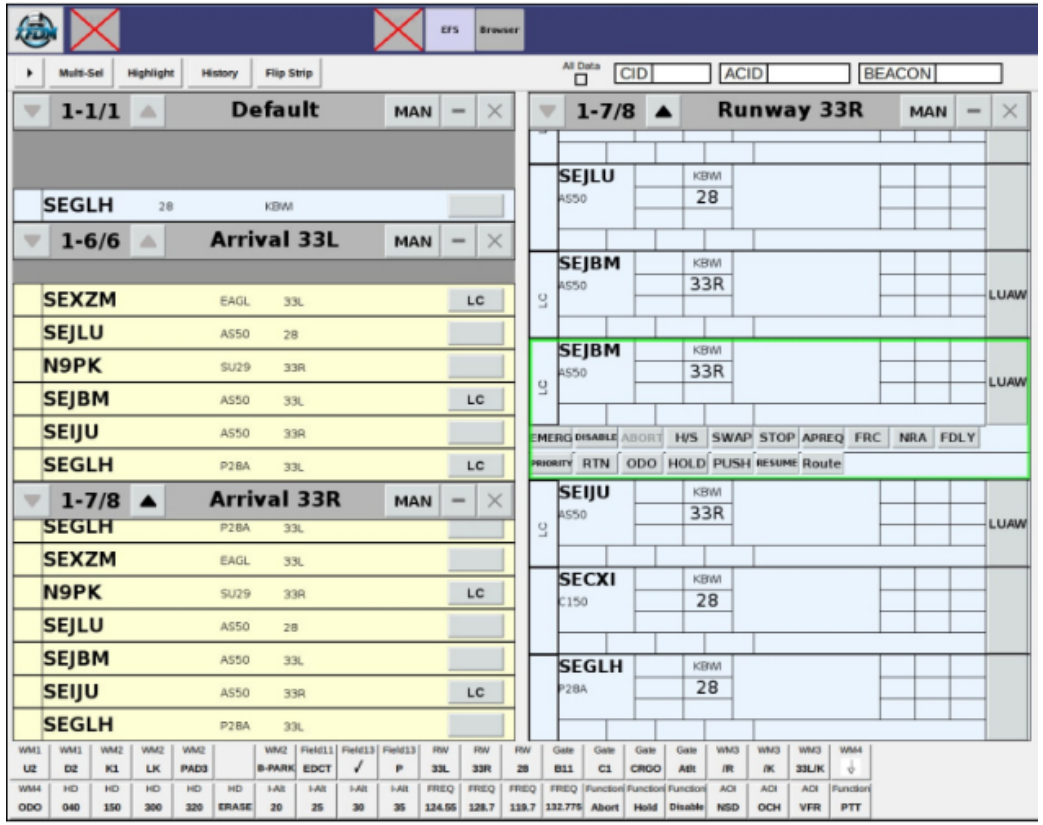
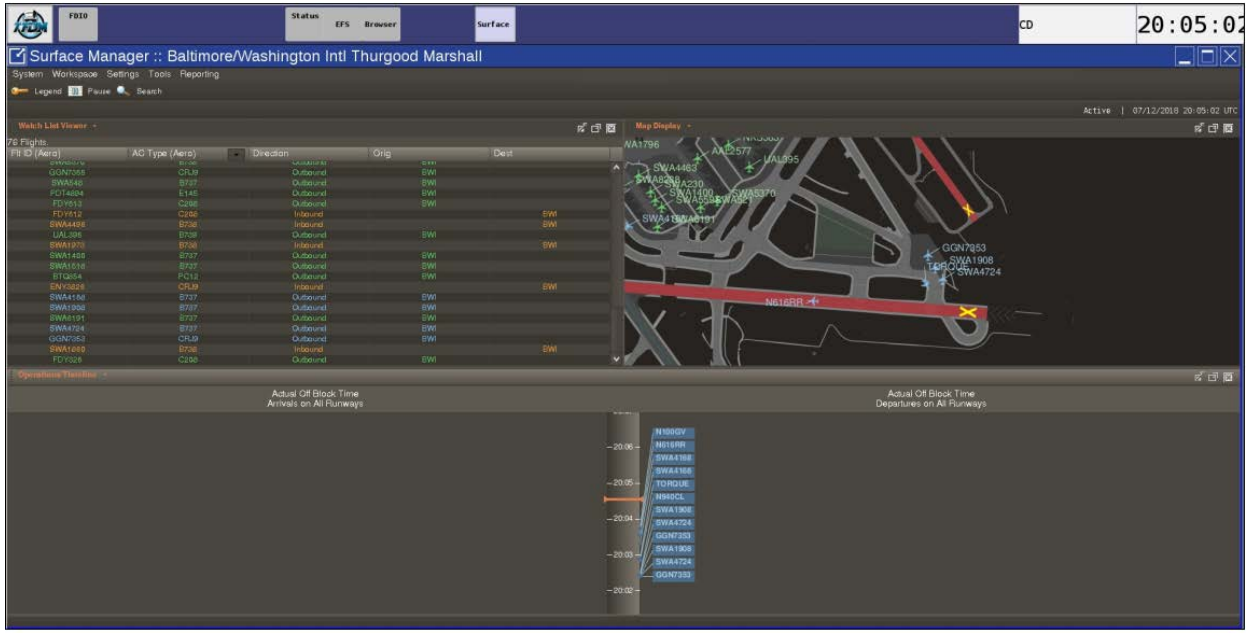
How TFDM Works

Electronic Flight Strips

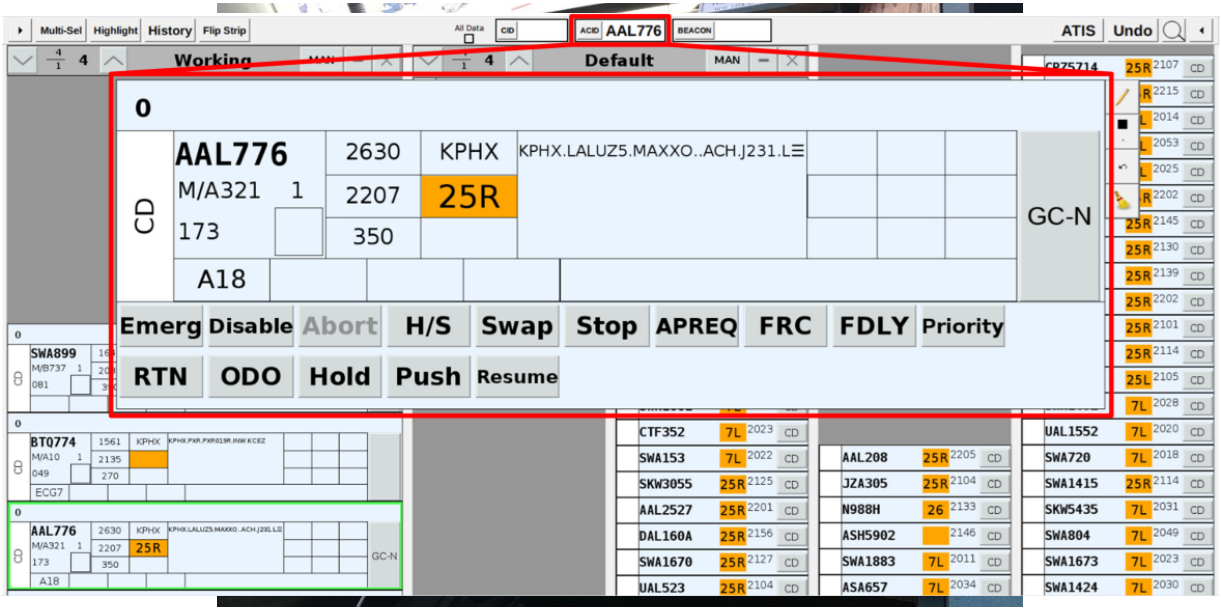


Surface Metering



Electronic Flight Strips (EFS)

- Replace paper flight strips in 93 air traffic control towers at 89 airports across the U.S.
  - Increase efficiency and safety
    - Automatic updates
    - Flight data consolidation
    - No lost flight data
    - Advisories on closed runways
    - More “heads-up” time



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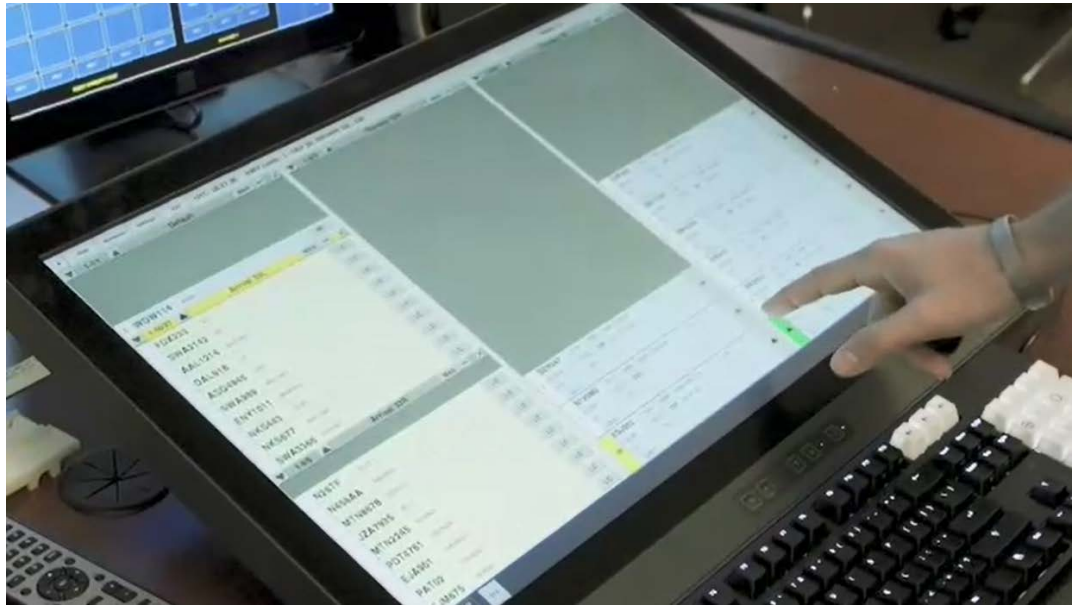
Electronic Flight Strips



Automatic updates will include:

- TMI release times
  - APREQ
  - EDCTs
- Miles/Minutes in Trail
- Reroutes
- Surface metering information (TMATs)
- Ground Stops

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Surface Metering Introduction: Terminology

- EOBT: Earliest Off Block Time
  - Earliest time a Flight Operator would be able to push back or taxi from its parking stand for departure
- TOBT: Target Off Block Time
  - Target time to push back from a gate or taxi from parking stand for a flight to make its movement area entry time
- TMAT: Target Movement Area entry Time
  - Target time for a flight to enter the movement area, within a variable window, during a surface metering program in order to maintain the target queue length

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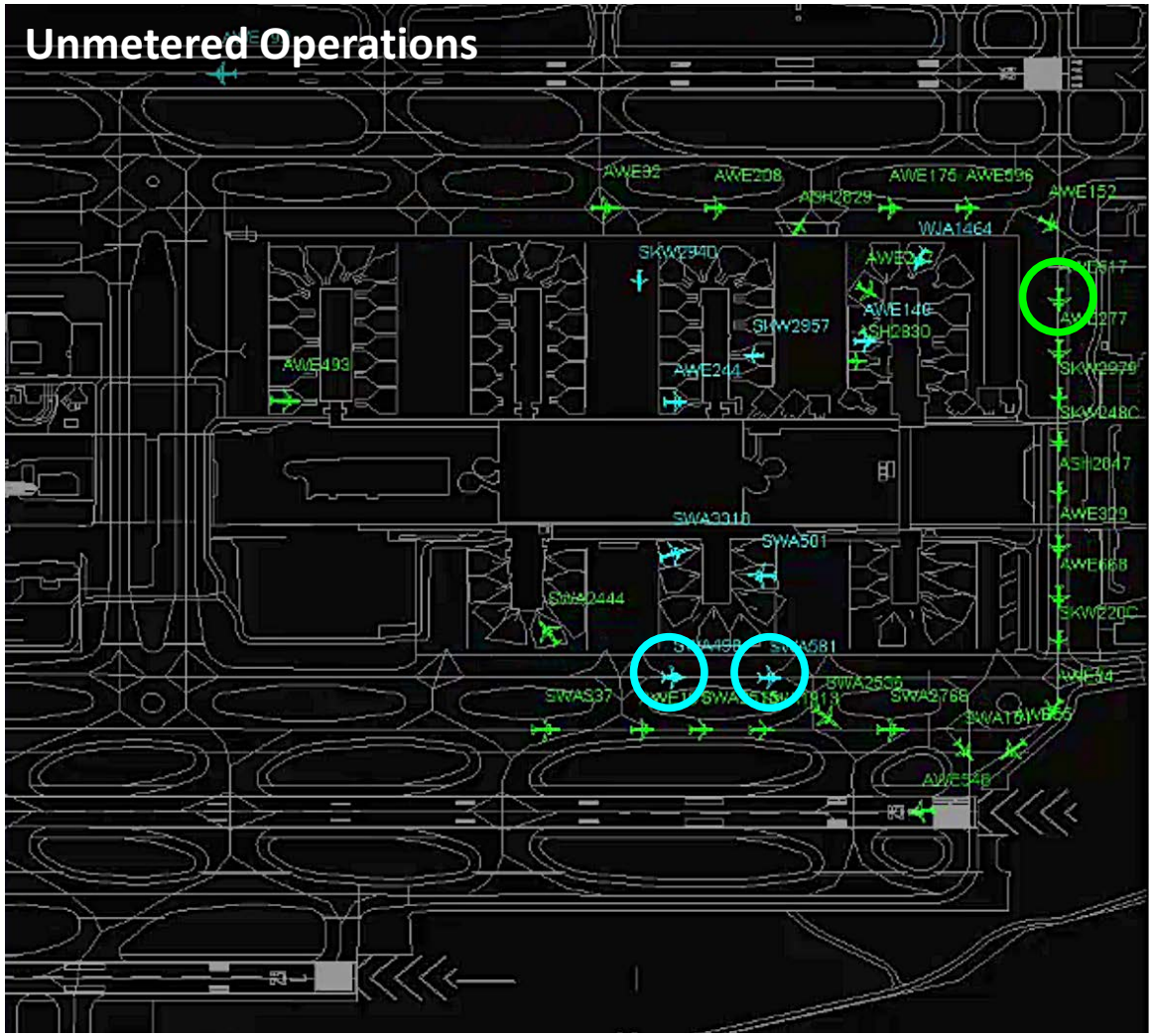
Why Surface Metering?

Surface congestion on the rise

- Infrastructure cannot keep up with demand
- Time on surface is increasing
- Surface metering is one method of alleviating the congestion
- Requires cooperation from
  - FAA
  - Flight operators
  - Airport authorities



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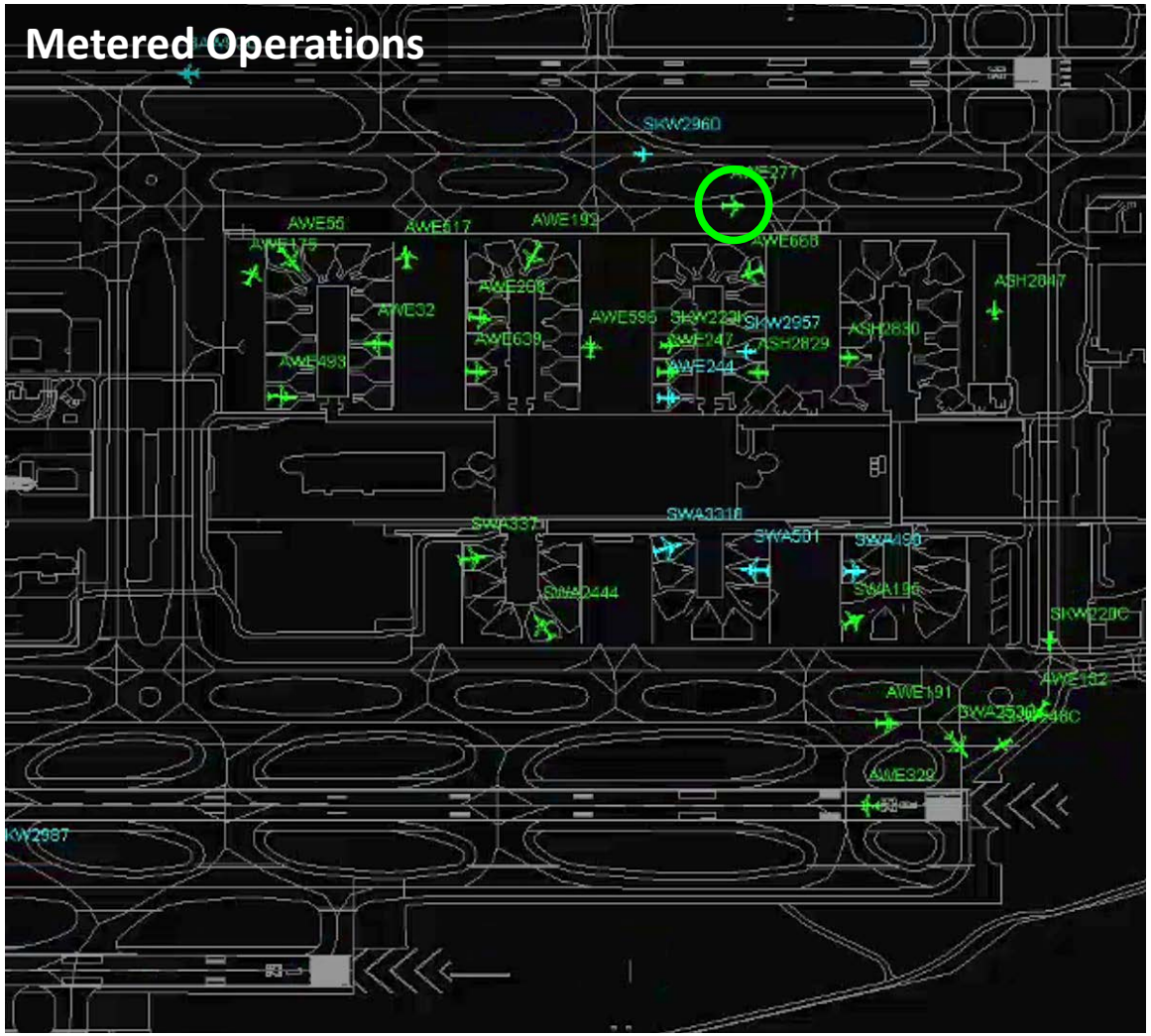
What is TFDM Surface Metering?

- Decision Support Tool
  - Solution using best available data
  - System recommends a Surface Metering Program (SMP) to the TMU
  - Uses pre-determined locally adapted procedures
  - Monitors current situation and predicts future state



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Surface Metering: How It Works

- Data exchange
  - Real-time via SWIM
  - Based on the ability to accurately predict pushback times
- TFDM scheduling functionality is always running
  - Look ahead variable by site. Continuously evaluates and updates
- Identifies demand that exceeds set queue length
  - Offers TMU a program

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Surface Metering: Queue length

Queue length is the number of aircraft in line to depart

- Target queue length set by runway or airport configuration
- Operational conditions (IFR or VFR)
- Adaptable buffer on queue length
- TMATs issued to manage queue length

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TFDM Individual Stakeholder Benefits

Flight Operators

- Improved schedule predictability/crew utilization
- Less taxi time/fuel burn (**313 million gallons**)
- Increased reliability of connections
- Aircraft may be held at gate or in the non-movement area instead of in a long departure line on the taxiway

Air Traffic Control

- Automatically updated flight plans and electronic flight strips
- Easier rescheduling
- Fewer aircraft in the movement area and departure queue
- Improved surface situational awareness at the TRACON, ARTCC, and Command Center
- Improved safety—less heads down time

Airport Operators

- Reduced CO2 footprint (**3 million metric tons**)
- Reduce engine noise
- Improved predictability
- More balanced use of airport resources

Flying Public

- Improved predictability
- Fewer delays
- More reliable flight schedules
- Improved passenger satisfaction

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TFDM Terminal Publication (TTP) Services Overview

- TFDM Terminal Publication Service is a collection of TFDM related SWIM Services
  - TFDM Systems at individual airports produce variety of TFDM related data for consumption
  - Has provisions for restricting sensitive data

- TTP Services Include:
  - Flight Data
  - Flight Delay
  - Airport Information
  - Traffic Management Restrictions
  - Operational Metrics
  - Surface Metering Program

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S-CDM: TFDM SWIM Services

TFDM Terminal Publication (TTP)

Business Function	Explanation	Type	Data Examples	Intended Users
Airport Information	TFDM derived airport data	Pub/Sub	Active Runway Configuration, Rates, Airport Delays, Runway Closures	FAA & Flight / Ramp / Airport Operators
Flight Data	TFDM flight data	Pub/Sub	Block Times, Takeoff Times, ATC Flight State, Runway Assignments	FAA & Flight / Ramp / Airport Operators
Traffic Management Restrictions	Airport specific traffic management restrictions and impacted flights	Pub/Sub	MIT, MINIT, Departure Stop	FAA & Flight / Ramp / Airport Operators
Flight Delay	Airport specific flights in delays with delay information	Pub/Sub	Flight ID info, delay duration, reason	FAA and CDM participants
Operational Metrics	Airport based operational metrics	Pub/Sub	Data Quality, Off Block Accuracy, TMAT Compliance, Emissions	FAA and CDM participants
Surface Metering Program	SMP information (only 27 Configuration A sites)	Pub/Sub	SMP information (e.g. start/stop time), lists of impacted flights	FAA and CDM participants

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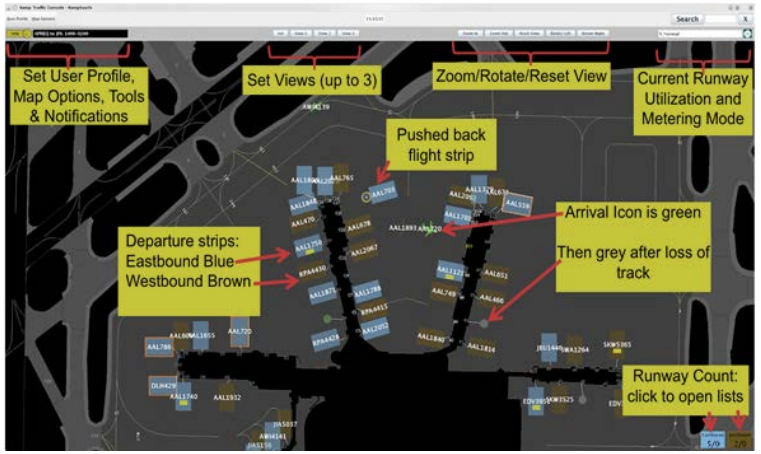
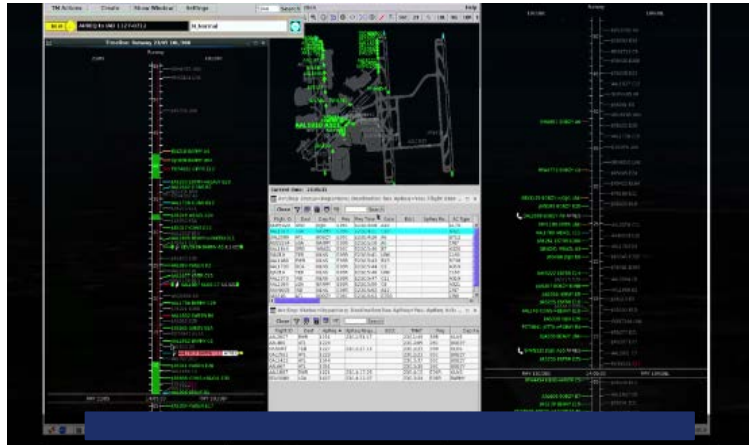
What is Airspace Technology Demonstration 2 (ATD-2)?

- NASA/FAA/Industry collaborative project that demonstrates the benefits of an integrated arrival, departure and surface (*IADS*) traffic flow decision making process while introducing new trajectory based operations (*TBO*) technologies and procedures
- Responds to a NextGen Advisory Committee (NAC) recommendation/need

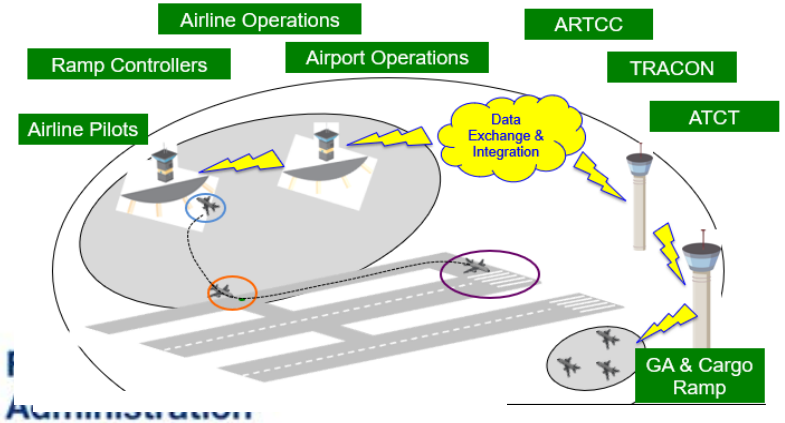
Collaborative Surface Metering



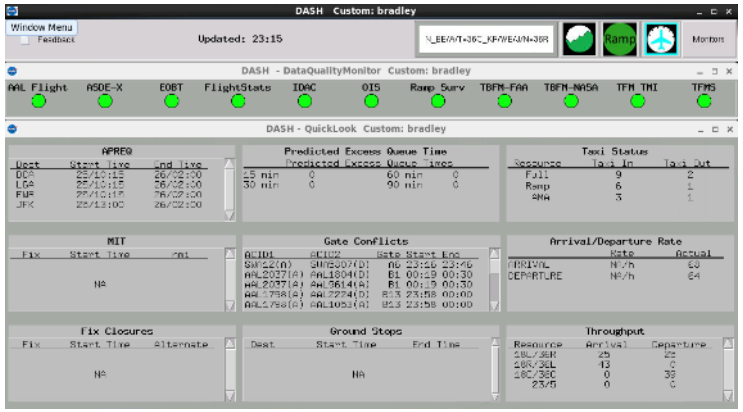
Overhead Stream Operational Integration



ATC/Operator Data Exchange and Integration

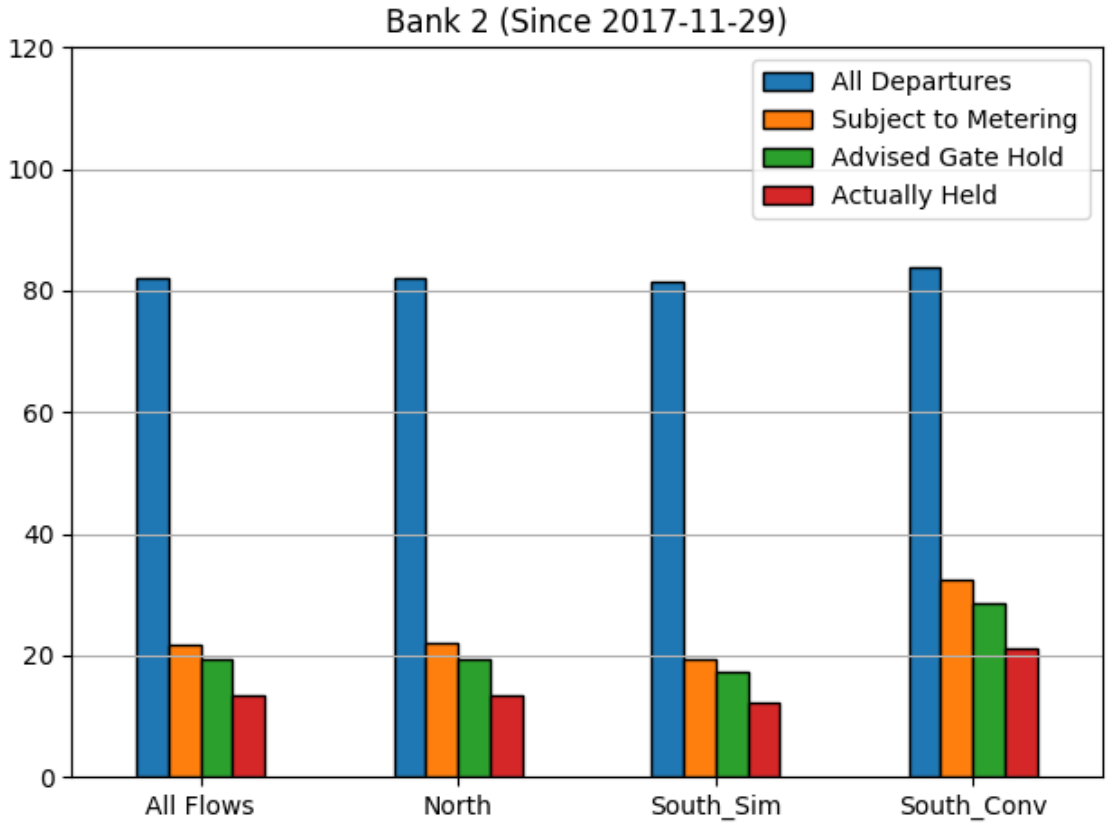


Initial Digital Transformation of Airport Surface



Average Departures During Metering

- More departures were subject to metering and held at the gate in Bank 2
- Among all the departures in Bank 2
  - 26.4% of departures were subject to metering
  - 23.5% of departures were advised a gate hold
  - 16.4% were actually held at the gate



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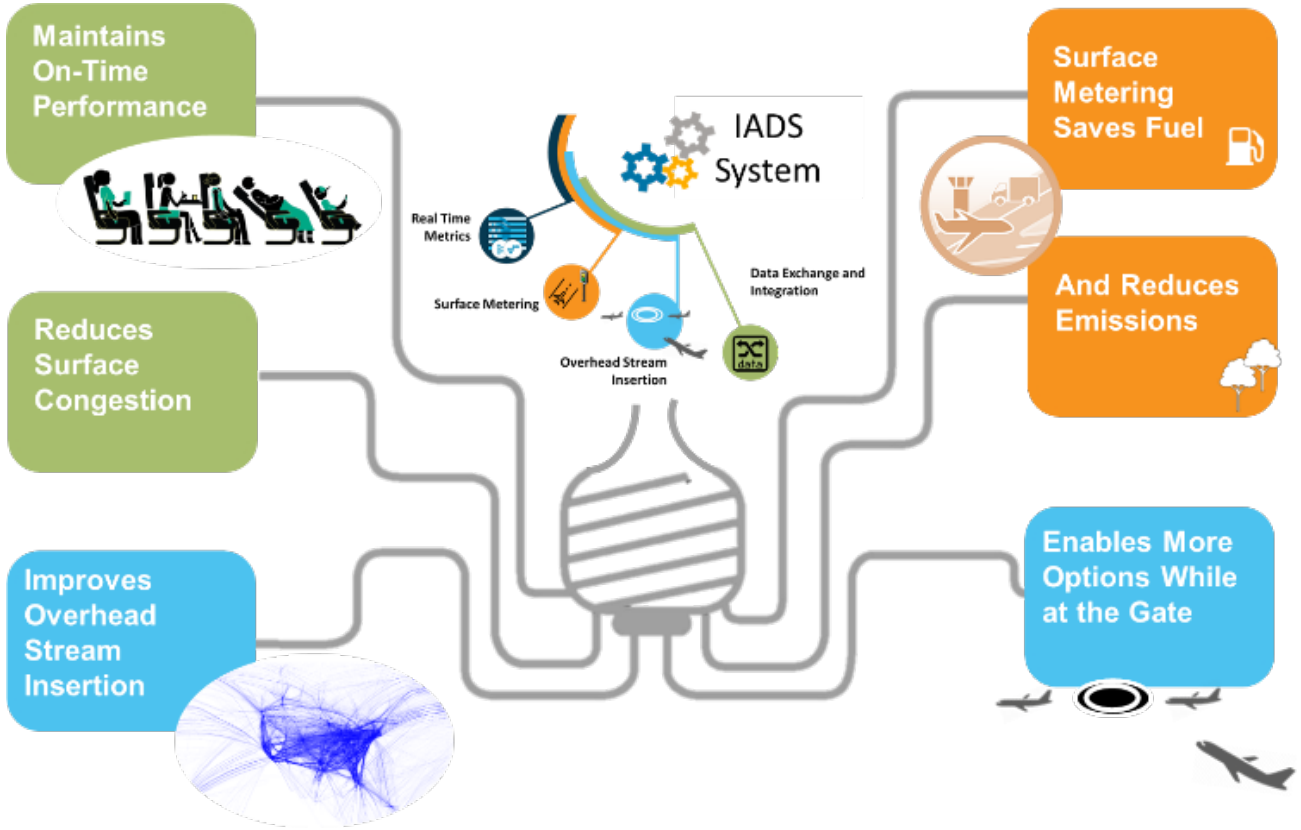
Demonstrating Benefits in the Field

- Multiple benefits mechanisms (benefits through 2019-05-06)
  - 2,295,383 lbs. of fuel saved
  - CO_2 savings equivalent to 82,226 urban trees
  - 270.7 hours of surface delay saved
    - $1,299,413 passenger value of time
    - $368,206 flight crew costs
  - 1,777 hours of reduced runtime on engines



TFDM Substitution Overview

- TFDM will provide a SWIM interface for flight operators to substitute flights within an SMP.
- Flights may be substituted after an SMP is approved or “affirmed” (i.e., TMATs assigned); to be eligible for substitution:
  - All flights must be part of the same SMP
  - All flights must be operated by the same major carrier as defined in TFMS (includes regional affiliates)
  - A flight may not have passed its metering control point (exception for flights with intent to hold in AMA)
  - A flight may not be exempt from rationing
    - Flights with control times (EDCT/APREQ), diversion recovery
  - Substitution times match according to exact or inexact rules
- Delayed or Canceled flights may be “marked for substitution” prior to an SMP being affirmed, allowing the flight operator to preserve a “slot” with the flight’s original departure time for substitution later.

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Key Substitution Terminology

Term	Definition
Earliest Off Block Time (EOBT)	Data element provided by the Flight Operator to indicate the earliest the flight operator could depart from its gate.
Marked for substitution	Allows TFDM automation to assign a metering time based on the IOBT priority of the flight without regard to the flight being delayed or cancelled by the flight operator.
Protection Period	Locally agreed upon time that a Flight Operator has to substitute a delayed or canceled flight before automation reclaims the allocated capacity.
Reclamation Window	Period of time measured from the current time forward beyond which the automation will not act on a canceled or delayed flight to reclaim capacity.
Static Time Horizon (STH)	Configurable amount of time from current time used to limit TMAT changes to flights. An important parameter in assigning TMATs to unscheduled flights.
Target Movement Area Entry Time (TMAT)	A metering time assigned to flights that are subject to any SMP.
Target Off Block Time (TOBT)	Advisory time that TFDM recommends a flight depart from its gate in order to comply with a TMAT or other control time.

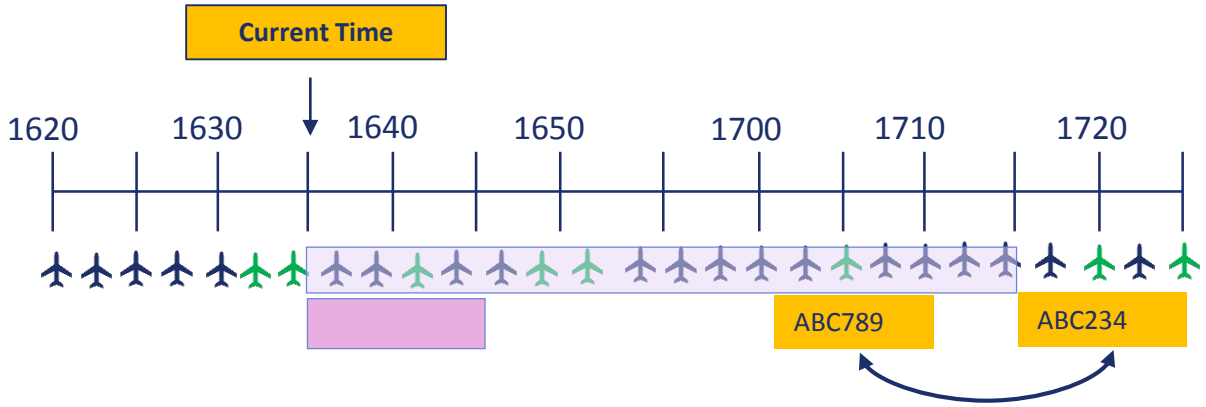
Substitution Scenario #1: Simple Substitution

1. At 16:35, one of the baggage belts used for loading ABC234 fails. The ramp reports to ABC dispatch they'll need to find another bag belt and that ABC234 is to be delayed 20 minutes.
2. ABC Airlines dispatch updates the EOBT for ABC234 to 1700.
3. ABC234 is inside the TMAT Reclamation Window. TFDM automation will allow only 10 minutes (Protection Period) for ABC airlines to decide how to use the TMAT vacated by the delay to ABC234.
4. ABC Airlines has until 1645 to use the TMAT held by ABC234.
5. At 16:37, ABC Airlines submits a substitution request to TFDM indicating that ABC234 and ABC789 will swap TMATs.
6. TFDM automation approves the request and reassigns the TMATs to ABC234 and ABC789.
7. ABC234 now has an EOBT: 1700, TOBT: 1710, TMAT: 1720
8. ABC789 now has an EOBT: 1655, TOBT: 1655, TMAT: 1705

Initial Scenario Set Up

- Surface Metering Program Active @ LAX beginning at 1600 through 1900
- Current Time: 16:35
- ABC234 has an EOBT: 1640, TOBT: 1655, TMAT: 1705
- ABC789 has an EOBT: 1655, TOBT: 1710, TMAT: 1720
- Static Time Horizon is 30 minutes
- TMAT Reclamation Window is 40 minutes
- TMAT Protection Period is 10 minutes

TMAT Timeline for LAX Departures



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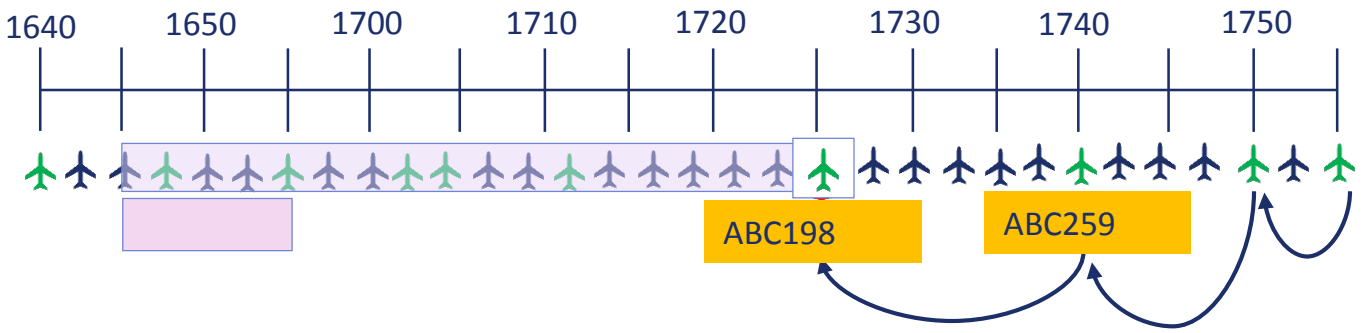
Substitution Scenario #2: Advanced Marking for Substitution

1. At 1200Z, ABC Airlines cancels ABC542 due to a snowstorm at the arrival airport.
2. ABC knows a surface metering program will be implemented later (@ 1400Z) and does not want to lose the TMAT "slot" from ABC542.
3. ABC submits the "marked for substitution message" (✓) for ABC542 and submits a cancellation message to TFDM automation (via TFMS).
4. TFDM automation accepts the marking and sends an acknowledgement message.
5. At 1400Z, when the SMP initiates, TFDM assigns a TMAT of 1725 to ABC542.
6. ABC has until 1655 to utilize the TMAT held by ABC542 (TMAT-Reclamation Window + Protection Period) or TFDM automation will reclaim the slot.
7. At 1630Z, ABC decides to substitute ABC198 into the TMAT slot held by ABC542. ABC submits the substitution request to TFDM and TFDM accepts the substitution request and sends an acknowledgement to ABC.
8. ABC198 now has an EOBT: 1715, TOBT: 1715, TMAT: 1725.
9. Since the slot vacated by ABC198 is outside of the STH, TFDM will utilize ration-by-schedule algorithms to automatically fill the TMAT vacated by ABC198 with another ABC airlines flight (ABC259).

Initial Scenario Set Up

- Surface Metering Program @ LAX beginning at 1600 through 1900
- Surface Metering Program will be affirmed at 1400 (TMATs assigned)
- ABC542 has an EOBT: 1700 TOBT: 1715, TMAT: 1725
- ABC198 has an EOBT: 1715 TOBT: 1730, TMAT: 1740
- Static Time Horizon is 30 minutes
- TMAT Reclamation Window is 40 minutes
- TMAT Protection Period is 10 minutes

TMAT Timeline for LAX Departures



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Flight Intent

- Flight Operators can provide “intent to hold in the movement area” message to indicate departure (or arrival) flights that need to hold in the movement area
  - **Benefit:** Provides flight operator flexibility to move aircraft off gate, but remain compliant with TMAT

- Use Case:
  1. During an SMP, flight operator needs a departure flight to exit the ramp early (prior to its assigned TMAT)
  2. Flight operator submits an “Intent to Hold in the Movement Area” message
  3. TFDM receives “Intent to Hold in the Movement Area” and displays this to ground controller
  4. Ground controller coordinates with pilot to taxi plane to hold area
  5. When flight reaches its TMAT, ground control will initiate taxi instructions to runway

- Flight Intent messages are submitted by the flight operator via TFMData (SWIM)
  - TFDM receives flight intent messages from TFMData

- Other flight intent messages can be provided by flight operator (all via TFMS SWIM)
  - Intent to Hold in the Non-Movement Area (arrival and departure), Return to Gate Intent

Airport and Flight Operator Role

- Participate in local agreements
- Processes for data submission and retrieval
- Provide accurate data (EOBTs)
- Comply with TMATs
- Understand role of TOBTs
- Participate in review of operational metrics like EOBTs and TMATs

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